

# Renewable Energy Demand A Case Study of California

**R E P P**  
RENEWABLE ENERGY POLICY PROJECT

GEORGE STERZINGER  
Jerry Stevens

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## **REPP STATE REPORTS**

A national program to develop renewable energy will provide significant benefits to states and regions well beyond where projects are developed. A national program will greatly stimulate demand for manufactured components. It is clear from earlier Reports undertaken by the Renewable Energy Policy Project that many of the states and regions that have suffered the greatest loss of manufacturing jobs have a significant concentration of manufacturing potential to supply those components. This potential is little understood even by those closest to it and who stand to benefit the most from it. The REPP State Reports intend to provide an explanation of how this manufacturing potential is calculated and offer detailed analysis showing for a state, region, and county the potential for each of the 43 industrial codes that comprise the major component parts for the major renewable energy technologies. It is hoped that the Reports will spur interest at the local level to actually identify the specific firms that could benefit from a national program and begin the discussion as to how best to tie reinvigorated domestic manufacturing activity into a national program to develop renewable energy.

## **Component Manufacturing: California's Future in the Renewable Energy Industry**

In August 2006 California passed legislation capping the state's CO<sub>2</sub> emissions. The legislation stabilizes California's emissions at 1990 levels by 2020; establishes a mandatory emissions reporting program; and establishes a "cap and trade" program allowing businesses to buy and sell emissions rights.

Skeptics of this action were quick to point out that the climate problem is global and California, acting alone as a single state, could not hope to stabilize it. Supporters responded that the point of the legislation was not so much to solve the problem by itself but to set an example that would hopefully move the United States as a whole to take on the problem. Not coincidentally, they also pointed out that by moving early California industry could be in a position to benefit from the national commitment when it came.

This Report analyses the renewable energy industry assuming that the United States moves to stabilize carbon emissions. As explained more fully below, the Report assumes a "wedge" of renewable energy is developed to stabilize the emissions from the US electric sector. The Report looks at how that major new demand for renewable energy will trickle down to create new demand for the component parts that make up the major renewable energy technologies.

Stabilizing emissions of carbon requires adding 18,500 MW of new renewable projects each year. The Report looks at the total demand generated by a ten-year stabilization program and tracks that demand down to the individual industries capable of manufacturing the components. The national demand is allocated to individual states and eventually to the county level. California, of all the states, has the greatest potential to generate new manufacturing activity to meet this demand. In all, there are more than 5400 firms in California that are currently active in the industrial sectors that could supply the component parts to meet the demand necessary to deliver a wedge. In addition, the demand can support the creation of more than 95,000 new jobs related to the expanded manufacturing activity.

The Report also looks at the likelihood that new demand on the scale necessary to stabilize carbon emissions would lead to bottlenecks in the component supply chain. To analyze the likelihood of this occurring, the Report looks at the incremental, annual demand for components as a percent of the available unused industrial capacity for each of the major industrial sectors. For example, climate stabilization will create an annual demand for approximately \$1 billion for wind turbine gearboxes. Currently, this industrial sector is running at close to full capacity. Department of Commerce data shows an available, unused capacity of roughly \$15 million. In other words, any major push for renewable installations would very likely run into an immediate shortage of these critical components. Looking more closely at this carbon stabilization program reveals that there is a very great likelihood that severe bottlenecks will develop in many critical sectors. For wind and PV, the annual, new demand will greatly exceed available industrial capacity for more than 50% of the industrial sectors. All technologies face a bottleneck in one or more critical components.

California, by acting early, can influence national action to accelerate climate programs. By virtue of its industrial base, California stands to benefit from the increased demand for renewable technology. California can also anticipate bottlenecks and begin developing the domestic industries that will allow a strong renewable industry to meet climate goals. To capture the potential and avoid bottlenecks will require aggressive investment from the private sector. Public policy and incentives can and should be used to accelerate that action.

## **STABILIZING CARBON EMISSIONS**

There are many ways to stabilize carbon emissions. For this Report REPP has used the “wedge” analysis developed by Pacala and Socolow. (Pacala, S. and R. Socolow, Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies, Science, 13 August 2004, Vol. 305) One of the breakthroughs that any complex issue like climate stabilization policy must make to gain public awareness and acceptance is to provide the public with a clear, comprehensible explanation of the problem and a solution that they can understand and believe will work. Their recent article in Science provided that threshold clarity for climate stabilization efforts. To stabilize carbon emissions, the authors proposed to split the growth of carbon emissions into seven parts or wedges and look for the set of already existing technologies that can generate the required electricity without a wedge of carbon emissions.

An international program of stabilization based on current levels of global emissions would make the United States responsible for about two wedges. Since transportation and electricity generation each provide about half the emissions, electricity generation in the United States would be responsible for about one wedge.

As the Science article makes clear there are a number of programs all using existing technologies that can be used to provide a wedge of carbon reductions but for this Report we look at what would be required to provide a wedge from renewable energy technologies.

The calculation of what is required to stabilize these emissions is exceedingly simple. The base of carbon emissions now is 7 billion metric tons per year of carbon growing at 1.5% per year. For the first year, global growth would be 105 million tons and to stabilize or remove the growth each wedge would require removing 15 million tons of carbon. Since the most common emission from the generation of electricity is CO<sub>2</sub>, the 15 million tons of carbon per wedge would translate to 55 million tons of CO<sub>2</sub> per year. Coal generation emits on average 2.1 pounds of CO<sub>2</sub> per kWh produced, that translates to approximately 58 billion kWh generated with zero CO<sub>2</sub> emissions to capture one wedge. (“Carbon Dioxide Emissions from the Generation of Electric Power in the United States” July 2000 Department of Energy Washington, DC 20585 Environmental Protection Agency Washington DC 20460). The assumption that each CO<sub>2</sub> free kWh removed a kWh of coal fired generation rather than natural gas fired generation is very likely imprecise. It is used here as a way to begin the discussion of how this type of program might work. It is not meant as a definitive resolution of these complex issues regarding electric generation dispatch.) To achieve these reductions would require the addition of between 18,000 and 19,000 MW per year of wind assuming an average capacity factor of 35%. (Biomass and geothermal resources have much higher capacity factors and would require smaller capacity additions to achieve the CO<sub>2</sub> reduction.) Once you hit the initial stabilization target the amount you need to add to hold emissions stable in the next year and for each year beyond that is exactly the same as the initial amount.

## **ANALYSING THE DEMAND FOR COMPONENTS**

It is well understood that a national program to develop renewable energy will benefit the regions and states that have the best renewable resource base – solar, wind, biomass and geothermal. What is less appreciated is that a national program will also create a demand for billions of dollars of components, the parts that make up the finished renewable plants. This demand could if accompanied by appropriate incentives provide important new markets for domestic manufacturers that are already manufacturing equipment similar to the components that go into new renewable generation. It is the intent of this Report to outline the potential for California from a national

commitment to accelerate renewable energy development. In 2004, the Renewable Energy Policy Project completed an analysis of modern, large wind turbine technologies. The results of this analysis were very encouraging both for the country as a whole and for California in particular. The Report showed:

“Investment in new wind will create a demand for all of the components that make up a wind generator. As a rule of thumb, every 1000 MW requires a \$1 Billion investment in rotors, generators, towers and other related investments... First we determine how the total installed cost of the new wind development will flow into demand for each of the 20 separate components of the turbines (grouped into 5 categories). Second, we spread the total demand among the regions of the country by allocating the ...investment according to the number of employees at firms identified by the NAICS codes. The number of employees is used rather than number of firms to account for the different impact of large vs. small companies, and hence to more accurately distribute the investment. This produces a “map” of manufacturing activity across the United States based on firms that have the technical potential to become active manufacturers of wind turbine components. Third, we translate the regional dollar allocation by assuming that all component manufacturing has the same ratio of jobs/total investment of 3000 FTE jobs/\$1 billion of investment...The results of this initial research into the distribution of manufacturing activity are encouraging. Twenty-five states have firms currently active in manufacturing components or sub-components for wind turbines; all fifty states have firms with the technical potential to become active. The table below shows the twenty states with would receive the greatest portion of the investment, based on the number of employees at potentially active firms identified by the NAICS codes for wind components.”

## I. National Rankings

The methodology we developed for the Wind Report has since been extended to cover photovoltaics, bio-mass steam generators, and geothermal technologies. For the combined renewable technologies, we assumed that 185,000 MW of wind would be developed, 23,150 MW of photovoltaic, 21,760 MW of biomass, and 15,190 MW of geothermal.

### Summary of National Development, Resulting Investment and Jobs

	Number of MW	Number of Firms	Millions \$ Investment	New FTE Jobs
Wind	124,900	16,480	\$62,338	398,470
Solar	23,150	10,272	\$69,624	298,194
Geothermal	15,190	3,926	\$15,330	72,324
Biomass	21,760	12,020	\$13,248	81,615
Total:	185,000	42,698	\$160,541	850,603

Nearly 43,000 firms throughout the United States operate in industries related to the manufacturing of components that go into renewable energy systems. If the 185,000 MW of renewable energy assumed in this model were to be developed, these companies have the potential to fill the demand for new components that would be generated. This national development would represent nearly \$160.5 billion dollars of manufacturing investment, and would result in more than 850,600 new jobs.

California is particularly well positioned to benefit from such a national development. As shown in the tables below, California stands to receive nearly 95,600 new jobs and \$20.9 billion dollars of investment in manufacturing components to supply this national development of renewables. California is ranked first among states in terms of job gain, and first for potential investment. (Note: The wind figures shown here are different from those in REPP’s initial wind manufacturing

report because we are using a more refined model that defines cost information at the component level.)

### **Manufacturing Jobs and Investment for 185,000 MW**

<b>Location</b>	<b># of Firms</b>	<b>Jobs Wind</b>	<b>Jobs Solar</b>	<b>Jobs Geothermal</b>	<b>Jobs Biomass</b>	<b>Jobs Total</b>
California	5,409	32,046	48,896	8,465	6,209	95,616
Texas	3,358	25,044	23,221	4,660	7,175	60,100
Illinois	2,289	30,010	19,298	3,396	3,875	56,579
Ohio	2,465	29,820	11,833	5,079	4,537	51,269
New York	1,925	18,523	14,617	8,150	6,640	47,930
Pennsylvania	2,188	19,588	15,767	3,402	3,911	42,668
Indiana	1,321	25,180	7,485	3,191	3,365	39,221
Michigan	2,050	24,350	6,644	1,502	2,281	34,777
North Carolina	1,096	10,964	11,062	2,810	3,708	28,544
Missouri	785	10,260	7,532	2,907	2,097	22,796

## **II. California and California Counties Information**

As shown in the wind report on manufacturing activity, California is particularly well positioned to benefit from wind energy development. When the picture is expanded to include other renewable energy technologies, the potential benefit to California manufacturing industries is even greater. As in the case of wind technology, California has a manufacturing base in most of the industries relevant to the production of renewable energy components.

### **Potential Manufacturing Benefit to California from National Development**

	<b>Number of Firms</b>	<b>Investment (Millions)</b>	<b>FTE Jobs</b>
Wind	1,943	\$5,449.50	32,046
Solar	1,788	\$12,115.90	48,896
Geothermal	348	\$2,181.10	8,465
Biomass	1,330	\$1,165.30	6,209
Total:	5,409	\$20,911.80	95,616

This report and the previous wind manufacturing report identify that California stands to benefit greatly from national renewable energy development through the chain of manufacturing. The next step is to identify ways to take specific action to move towards making this potential benefit a reality. In order to do so, it would be useful to have more specific information about the location and nature of the manufacturing potential in California. One important feature of the census information for manufacturing is that it goes down to the county level. This county level information makes it possible to take a closer look at the locations within a state that have the potential to manufacture components related to renewable energy. The methodology for arriving at investment and jobs numbers at the county level is the same as for the state level. Each county

receives a portion of the total investment from the national program, according to the percentage of firms in each of the relevant NAICS industries operating in that county. Jobs are distributed in the same manner.

**Table: Top 20 Counties in California**

County	Wind		Solar		Geothermal		Biomass		Totals	
	Millions	Jobs	Millions	Jobs	Millions	Jobs	Millions	Jobs	Millions	Jobs
Santa Clara	\$623.1	3,351	\$5,139.3	16,616	\$295.2	993	\$108.3	445	\$6,165.9	21,405
Los Angeles	\$1,228.8	7,816	\$1,838.5	8,955	\$311.2	1,413	\$269.7	1,662	\$3,648.2	19,846
San Diego	\$948.7	4,352	\$781.3	4,032	\$816.3	2,821	\$276.6	1,125	\$2,822.9	12,330
Orange	\$712.3	4,914	\$1,229.7	6,546	\$75.6	445	\$89.3	603	\$2,106.9	12,508
Alameda	\$282.1	1,859	\$532.7	2,012	\$11.5	81	\$13.7	95	\$840.0	4,047
San Bernadino	\$291.9	1,895	\$377.2	1,770	\$22.2	114	\$26.3	171	\$717.6	3,950
Ventura	\$173.7	1,191	\$366.4	1,373	\$17.5	115	\$26.4	186	\$584.0	2,865
San Mateo	\$32.9	225	\$498.7	2,234	\$0.4	3	\$3.5	22	\$535.5	2,484
Riverside	\$150.6	1,115	\$290.0	1,114	\$8.0	47	\$13.6	89	\$462.2	2,365
Fresno	\$84.5	540	\$196.2	880	\$39.6	229	\$15.1	93	\$335.4	1,742
San Joaquin	\$123.8	752	\$123.6	561	\$1.1	7	\$3.5	24	\$252.0	1,344
Sacramento	\$44.9	290	\$147.4	407	\$2.8	12	\$34.9	237	\$230.0	946
Sonoma	\$38.8	277	\$67.7	371	\$40.7	287	\$46.4	329	\$193.6	1,264
Placer	\$14.0	86	\$138.6	410	\$0.2	0	\$0.4	2	\$153.2	498
Tulare	\$54.5	384	\$83.0	509	\$2.2	13	\$6.6	45	\$146.3	951
Contra Costa	\$44.0	284	\$79.4	420	\$1.9	10	\$7.3	45	\$132.6	759
Solano	\$39.1	252	\$2.7	16	\$19.3	128	\$58.1	412	\$119.2	808
Kern	\$31.1	188	\$39.6	158	\$23.0	159	\$12.0	82	\$105.7	587
Santa Barbara	\$28.5	179	\$61.6	234	\$5.2	25	\$7.5	48	\$102.8	486
Santa Cruz	\$13.3	92	\$69.9	191	\$10.2	56	\$5.7	37	\$99.1	376

The table above lists the 20 counties in California that would receive the greatest investment in manufacturing from the national development of wind, solar PV, geothermal, and dedicated biomass. Here is how we made those calculations. The investment figure is arrived at by starting with a number of MW of new capacity for the entire U.S. In this case, we use 124,900 MW new wind for this report. This 124,900 MW results in a total manufacturing cost that is broken down into individual components. Each components share is calculated based on specific cost information (\$/MW) for each part. Each component also has an NAICS industry associated with it – for example, the wind turbine tower falls under the code 332312 “Fabricated Structural Metal”. Then the total dollars that go into making towers and the other components for the 124,900 MW of wind are divided into each county based on the relative number of firms operating in 332312 in that county (actually, the number of employees working at those firms is used to account for different size companies). This process is repeated for each part, and then summed to get the total for each technology. The number of new FTE Jobs is also based on census information. By combining the number of employees working in a given industry, the total value of components produced by that industry, as well as the cost per megawatt for those components, we were able to calculate a ratio of Jobs/MW for each NAICS industry for each of the four technologies. This number of jobs is then divided geographically in the same way that the investment was. To take a closer look at a particular county of interest, we can break out the investment and job allocation by specific NAICS codes, in order to examine the particular kinds of manufacturing that are relevant to a given county. As an example of this, we look at the California County which had the most renewable energy manufacturing potential: Santa Clara. While a variety of data is available, three items seemed

particularly relevant. The number firms operating in the county in each NAICS industry gives an idea of the manufacturing base located in the county for a particular industry, while the investment and new job creation, using the method described above, provide an idea of the potential for the county to benefit in particular industries from the national development of renewable energy. The following tables break out the results for Santa Clara County.

## Santa Clara, CA

### Wind

NAICS	NAICS Description	# Of Firms in NAICS	Millions \$ Investment	New FTE Jobs
335999	Electronic Equipment and Components, NEC	33	\$296.7	1,923
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	1	\$211.3	705
326199	All Other Plastics Product Manufacturing	40	\$37.6	300
334418	Printed circuits and electronics assemblies	50	\$32.8	139
334519	Measuring and Controlling Devices	19	\$31.2	206
332312	Fabricated Structural Metal	11	\$13.3	76
332991	Ball and Roller Bearings	1	\$0.1	1
335312	Motors and Generators	1	\$0.1	1
<b>Total:</b>		156	\$623.1	3,351

### Solar

NAICS	NAICS Description	# Of Firms in NAICS	Millions \$ Investment	New FTE Jobs
334413	Semiconductors and Related Devices	195	\$4,167.0	10,568
335999	Electronic Equipment and Components, NEC	33	\$744.4	4,826
334515	Instrument Manufacturing for Measuring and Testing	63	\$166.7	760
335931	Current-Carrying Wiring Device Manufacturing	8	\$29.4	224
332322	Sheet Metal Work Manufacturing	74	\$25.4	208
335313	Switchgear and Switchboard Apparatus Manufacturing	5	\$3.3	18
335911	Storage Batteries	1	\$1.3	7
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	2	\$0.9	4
325211	Plastics Material and Resin Manufacturing	2	\$0.9	1
<b>Total:</b>		383	\$5,139.3	16,616

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investment	New FTE Jobs
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	1	\$292.9	977
332410	Power Boiler and Heat Exchanger Manufacturing	2	\$1.8	13
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$0.3	2
333912	Air and Gas Compressor Manufacturing	1	\$0.2	1
<b>Total:</b>		6	\$295.2	993

## III. Component Breakdown and NAICS Methodology

Assessing the dispersion of manufacturing of the components of renewable energy systems proceeds in 3 steps, First we identify the component parts that make up each system, then we identify a relevant NAICS code for each component, and finally we use the census data to identify potential manufacturing activity.

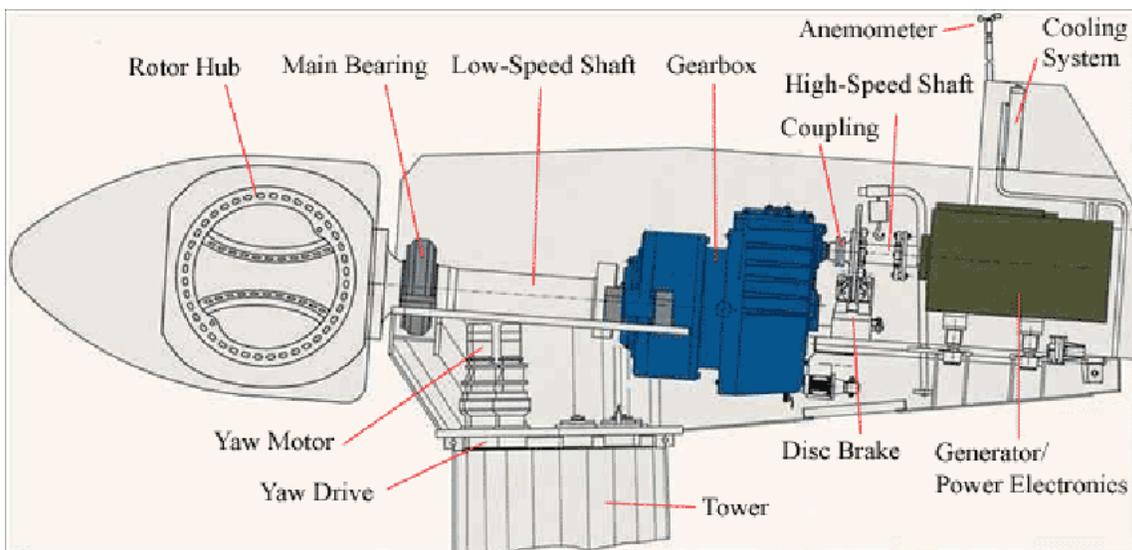
### A. Component Breakdown

In doing so, we must decide what constitutes a major component – for this study we consider a part that would likely be sold by a manufacturer as a single unit, and not the parts that went into that unit further up the supply chain. For example, we consider the gearbox in a wind turbine as a component, but not the bolts that went into making the gearbox. For each of four technologies –

wind, solar PV, geothermal, and biomass generation – we identified the most prevalent modern technology, and then identified the major components that go into each.

## 1. Wind Technology

For wind technology, this Report looks at utility scale modern wind turbines, which are three bladed, upwind, horizontal axis machines, typically larger than 1 MW capacity. In this type of wind turbine, wind flows over three large composite blades mounted on a rotor, causing them to rotate. The rotational energy is transferred through a gearbox to a generator, where it is converted into electricity. Almost all wind turbines currently being installed for power generation for electric utilities are of this kind. We identified 19 separate components for the utility scale wind turbine, many of which are shown below in Figure 1. For a complete list of the components and a description and photograph of each, please refer to Appendix A.



**Figure 1 – Wind Turbine Component Diagram**

## 2. Solar Technology

For solar photovoltaics, we considered crystalline silicon modules, as these are by far the most common type of PV module currently deployed. Although not specifically considered in this report, amorphous silicon and other “thin-film” modules are also produced in small amounts in a handful of countries. However, with the exception of the glass top plate and the framing structure, the components for both systems are practically the same and so much of what is written in this report will also apply to thin-film modules. All PV systems convert the energy from photons striking the cells into electrical current. This direct current electricity is then either stored in a battery for later use, or converted into AC power by an inverter, which can then be connected to household appliances and to the electric grid. We identified 13 separate components for solar PV systems.

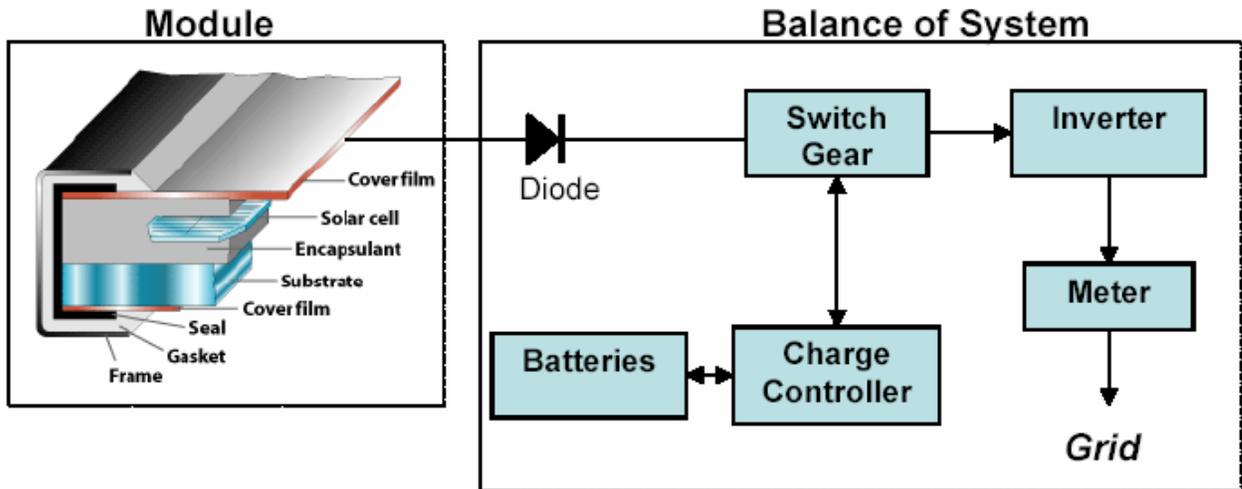


Figure 2 – Solar PV Component Diagram

### 3. Geothermal Technology

For geothermal power generation, we considered two technologies which represent almost all of the current operating and planned plants – flash steam and binary cycle. Flash steam plants operate by expanding the hot geothermal fluid to make steam, which is then passed through a steam turbine-generator set to make electricity. The steam is then condensed, and in most cases the excess fluid is re-injected underground to preserve the resource. In a binary plant, a fluid with a low boiling point is circulated in a closed loop, receiving heat from the geothermal fluid through a heat exchanger, vaporizing, being expanded through a turbine-generator, and then re-condensed. Most of the components that make up these plants are similar, such as various pumps, heat exchangers and piping, but a handful of parts are distinct for each technology. Listed below are the components that both technologies have in common, and then those that are specialized for each type of plant. The figures below illustrate the major components of a flash steam plant and a binary cycle plant.

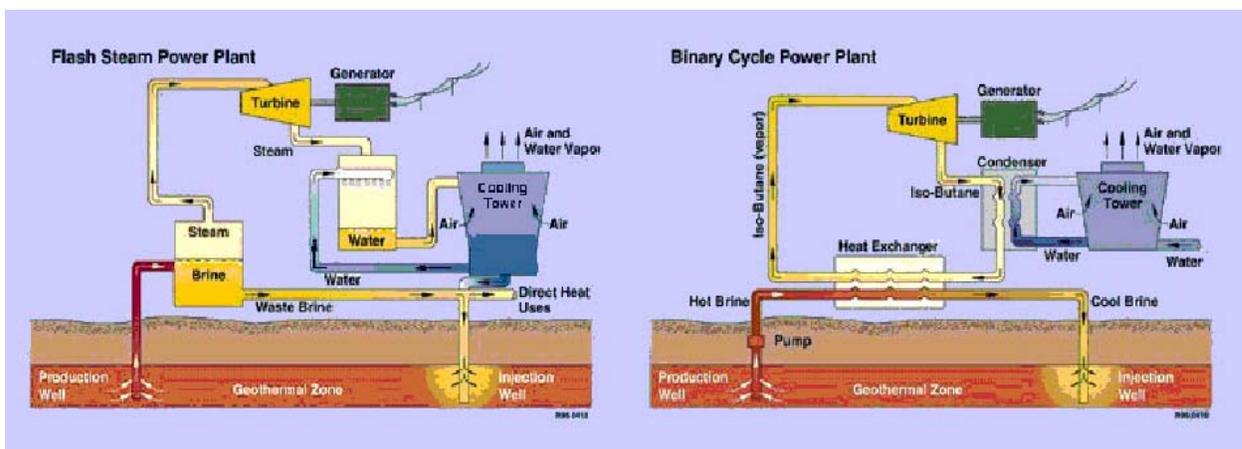
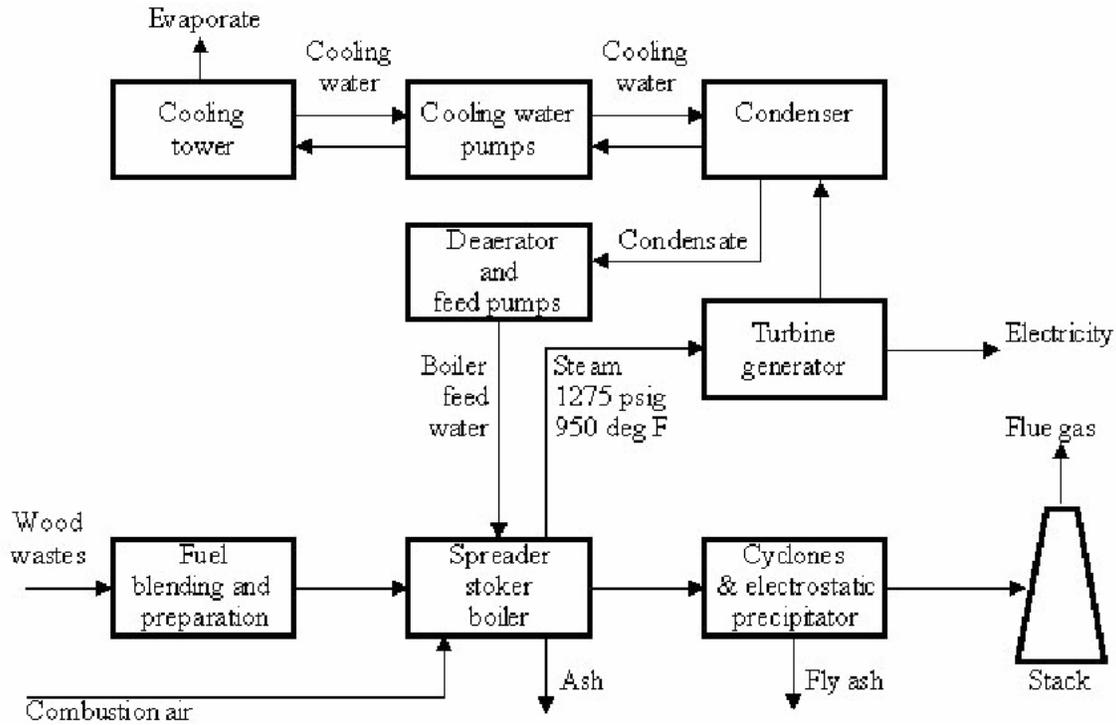


Figure 3 – Geothermal Component Diagram

#### 4. Biomass Technology

For biomass power generation, we looked at dedicated biomass plants (as opposed to co-firing with coal) that burn biomass in a boiler to generate steam. The steam is then passed through a steam turbine-generator, just like the kind used in coal or other fossil-fuel plants, to generate electricity. While other methods of power-generation from biomass exist, such as gasification or anaerobic digestion, direct steam plants are the most common, and are the only technology widely ready for commercialization. We identified 33 separate components for a biomass-fired steam plant.



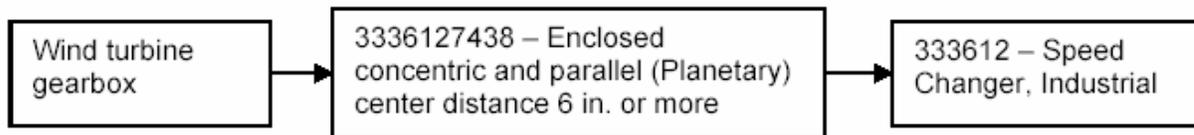
**Figure 4 – Direct-fired Biomass Steam Plant Component Diagram**

#### B. Identifying the NAICS Codes

Manufacturing activity has historically been tracked by Standard Industrial Classification (SIC) codes. The four-digit SIC code was developed in the 1930's to classify businesses by the type of activity in which they are primarily engaged and to promote the comparability of business data to describe various aspects of the U.S. economy. In 1997 the SIC was replaced by the North American Industry Classification System (NAICS). In the Economic Census conducted by the U.S. Census Bureau, every firm operating in North America reports one or more NAICS codes, indicating what types of products or services they provide. Companies reporting the same NAICS code are involved in similar activities, for example every company that reports “333911” manufactures some type of pump. Using this system, REPP was able to tabulate the companies involved in activities similar to the manufacturing of renewable energy components.

The NAICS codes have several levels of detail, up to ten digits, with each digit indicating a higher level of detail. For example, a first digit of 3 indicates Manufacturing, 333 is “Machinery Manufacturing,” 333911 is “Pump and Pumping Equipment Manufacturing,” and 333911148M is “All other centrifugal pumps, over 6 in. discharge.” For this report, we matched each component with a 10-digit code, the highest level of detail in the NAICS, in order to ensure that we had

accurately identified the correct code. We then went back up the hierarchy to the 6-digit code for interfacing with the census data.



### **Advantages to Using the 6-digit Codes**

The 6-digit NAICS codes replaced the 4-digit SIC codes, which were the highest level of detail available in the SIC. Hence the 6-digit NAICS are the standard level reported by all companies in North America, with the 10-digit codes providing additional detail. The U.S. Census Bureau itself provides data primarily at the 6-digit level, reporting 10 only at the request of a special study. Furthermore, for a given NAICS code and a given geographical area, such as a county, if there are less than 2 companies operating or if one company is dominant, disclosure rules require the Census to not report information for that particular code and for that area, to avoid disclosing private company information. The small number of companies reporting in a given 10-digit code makes it unlikely that information would be available for all codes and states. Therefore, for this study we had to rely on the 6-digit codes. Additionally, the specificity of a 10-digit code could have excluded companies with good potential for entering the geothermal market, which the 6-digit industry code includes.

### **Caveat to Using the 6-digit Codes**

When interpreting the results of a 6-digit code search, it is important to be aware of the potential broadness of companies included. For example, under the 6-digit NAICS, charge controllers and inverters fall under “Electronic Equipment and Components, Not Easily Classified.” Along with rectifying equipment, such as inverters, this also includes laser power supplies and ultrasound equipment. However, this is mostly a problem for one or two particular codes, the majority of NAICS codes used in this study have much less variation of product type. Furthermore, even a company that makes laser power supplies has a significant advantage over a company starting from scratch, as they have basic knowledge and capabilities for making sophisticated electrical equipment.

## **C. Identifying the Economic Impact of Renewables Manufacturing**

To provide an estimate of market development, we must start with a figure for the amount of development to occur in each of the technologies considered in this report. This assumed development figure drives the demand for manufacturing of the components, which in turn creates the potential for economic development in locations that could supply these components. The intention of this report is not to take guesses at the number of MW of renewable energy likely to be installed in the next 20 years; rather we simply take some reasonable numbers to provide an estimate of the economic potential. The table below lists the drivers we used for each of the four technologies, and their source.

## Sources for Assumed National Development

Energy Source	Number of New MW	Source
Wind	124,900	Pro-rated Carbon Stabilization Wedge
Solar PV	15,190	Pro-rated Carbon Stabilization Wedge
Geothermal	23,150	Pro-rated Carbon Stabilization Wedge
Biomass – Dedicated Steam	21,760	Pro-rated Carbon Stabilization Wedge

### Investment Allocation

Having identified components and a NAICS code for each, the next step in determining the potential involvement of this manufacturing base in the development is to determine how demand will flow into each industry based on component cost information. This cost information results in a dollar amount allocated to each industry. Each component is assigned a specific cost (\$/MW) based on research by REPP into the most relevant current cost study for each technology. The table below summarizes the sources for cost information for each of the technologies.

### Sources for Component Cost Information

Energy Source	Component Cost Information Source
Wind	NREL WindPACT Study
Solar PV	Solar PV Industry Roadmap, as well as NREL Solar Energy Technologies Program
Geothermal	EPRI “Next Generation Geothermal Power Plants”
Biomass – Dedicated Steam	Capital costs for the McNeil Generating Station in Burlington, VT

The cost allocated to each component group is then allocated to states and geographic regions according to the number of employees working for companies with the technical potential to manufacture components in that component group. The number of employees is used rather than number of firms to account for variation in size of the firms. A firm employing 1,000 people will bring a larger investment to a region than one employing 10. To illustrate the allocation, consider the Fabricated Structural Metal, which has a specific cost of approximately \$123,000 per MW of wind capacity. Multiplying by the 124,900 MW of wind assumed as the driving development results in a total investment in Fabricated Structural Metal manufacturing of \$15.4 billion. This \$15.4 billion is now allocated geographically. Consider Santa Clara county in California, which has 76 employees working at firms operating in the NAICS code for Fabricated Structural Metal (NAICS Code – 332312), as compared to 106,161 employees in the entire U.S. Therefore, Santa Clara gets 76/106,161 or 0.072% of the \$15.4 billion dollars, which means around \$11.1 million goes to Santa Clara for the NAICS industry associated with Fabricated Structural Metal (you can check this by looking at the Santa Clara Wind breakdown in Section II of this report). To get the total investment for given county or state, we then simply sum up the investment for all of the NAICS codes.

### Jobs Allocation

We are also interested in investigating the impact of the national development of renewable energy on job creation. To do this, we assign a manufacturing job creation ratio to each of the component industry, a number of jobs created manufacturing in a certain industry per MW of new capacity. This ratio is calculated, again using the NAICS census data in combination with the specific cost information discussed above. For each NAICS code, the census reports the number of employees working in that industry, as well as the total value of products shipped from that industry. We make the assumption that this shipped value of a product is the same value represented in the specific cost information used for the investment allocation (the \$/MW for each component), Combining

these two pieces of information results in a number of employees per MW. Because the census value of shipments is calculated on an annual basis, this “number of employees” is equivalent to number of annual jobs, or an amount of labor equal to the number of employees’ times 2000 hours. The table below shows the total jobs/MW number for each technology, summing over all of the component parts:

Energy Source	Number of Jobs/MW
Wind	7.5
Solar	62.6
Geothermal	8.25
Biomass – Dedicated Steam	10.5

REPP had recently completed a study of the labor that goes into renewables which included a detailed survey of employment related to wind and solar PV. The overall manufacturing jobs/MW numbers found using the NAICS census method and shown in the table above agree well with the numbers found in the previous REPP study, giving confidence in the above method. Having obtained a jobs/MW number, the jobs are allocated geographically according to the census manufacturing in the exact same manner that the investment was allocated.

#### D. Identifying Potential Supply Bottlenecks

To identify potential bottlenecks in the component supply chain we first established for each NAICS code the current production capacity and compared that to the maximum available production capacity. For each NAICS code this difference established an Available Production Capacity. Available Production Capacity can then be compared to the Incremental Demand for parts from that NAICS code. The Incremental Demand is the annual demand related to the installation of the wedge of 18,500 MW. If the Incremental Demand is greater than the total Available Production Capacity, there is a strong chance of a bottleneck developing. Identifying these bottlenecks should be met with a concerted effort to begin building industrial capacity to avoid them.

**TABLE: IDENTIFICATION OF BOTTLENECKS IN WIND COMPONENT PARTS**

Wind 10 Digit NAICS Codes	Incremental Demand	Available Production Capacity	Incremental Demand as a % of Available Production Capacity
Nacelle Case	\$132,643	\$55,931	237.15%
Rotor Blade	\$1,133,332	\$477,888	237.15%
Blade Extender	N/A	N/A	N/A
Tower Flange and Bolts	N/A	\$25,554	N/A
Hub	\$471,700	N/A	N/A
Nacelle Frame	\$251,300	\$248,692	101.05%
Towers	\$1,476,550	\$381,607	386.93%
Bearings	\$145,075	\$240,042	60.44%
Cooling System	\$19,200	\$137,235	13.99%
Generator	\$551,900	\$99,554	554.37%
Gear Box	\$942,025	\$14,593	6455.34%
Brakes	\$33,606	\$75,786	44.34%
Coupling	\$16,015	\$58,101	27.56%
Shafts	\$135,254	\$173,851	77.80%
Electronic Controller	\$44,125	N/A	N/A
Sensors/Data Loggers	\$117,525	\$315,294	37.27%
Anemometer	\$0	\$315,294	0.00%

Pitch Drive	\$262,942	\$458,739	57.32%
Yaw Drive	\$58,433	\$101,945	57.32%
Power Electronics	\$447,150	\$191,626	233.34%

As the two Tables show that for Wind and PV there are severe bottlenecks in more than half of the crucial components.

**TABLE: IDENTIFICATION OF BOTTLENECKS IN PV COMPONENT PARTS**

<b>10 Digit NAICS Code</b>	<b>Incremental Demand</b>	<b>Available Production Capacity</b>	<b>Incremental Demand as a % of Available Production Capacity</b>
Encapsulant	\$248,575	\$1,099,869	22.60%
Rear Layer	\$260,300	\$1,520,380	17.12%
Top surface	\$479,950	\$50,904	942.86%
Wiring	\$241,550	\$57,176	422.47%
Frame	\$118,050	\$116,924	100.96%
Blocking Diode	\$93,327	\$75,510	123.59%
Solar cells	\$2,691,123	\$1,282,194	209.88%
Complete Module			
Meter	\$111,900	\$293,423	38.14%
Circuit Breakers and Fuses	\$108,875	\$343,195	31.72%
Switch Gear	\$105,310	\$861,303	12.23%
Electrical Connections	\$400,388	\$103,055	388.52%
Charge Controller	\$477,569	\$50,056	954.07%
Inverter	\$643,392	\$171,306	375.58%

A more complete explanation of the process and data used to identify potential bottlenecks is presented in Appendix D.

## **Appendix A – Component Descriptions and NAICS Codes**

The following pages contain a detailed description of all of the components that make up a wind turbine, a photovoltaic system, a geothermal power plant, and a dedicated biomass steam generation plant. The 10-digit and 6-digit NAICS codes for each component are also listed.

### **Table of Contents:**

Wind Components	.....	A2
Solar Components	.....	A12
Geothermal Components	.....	A20
Biomass Components	.....	A31

## Wind Components

### Bearings

#### NAICS Codes:      NAICS Descriptions:

**Subsector Code:**      Fabricated Metal Product Manufacturing  
332

**Industry Code:**      Ball and Roller Bearings  
332991

**Detailed Code:**      Other roller bearings, spherical roller bearings, including hourglass and barrel, double row  
3329915025



**Description of Subcomponent:**      A number of bearings are required for the shafts, gearbox, yaw mechanism, generator, and other rotating parts.

Source:  
<http://www.timken.com/products/bearings/products/sphericals>

A four-point contact ball bearing joins the nacelle and the tower, allowing the nacelle to slew about in order to face upwind and extract the maximum amount of energy from the wind. The main shaft rotates on large tapered roller bearings, or in some cases a large spherical bearing.

### Blade Extender

#### NAICS Codes:      NAICS Descriptions:

**Subsector Code:**      Primary Metal Manufacturing  
331

**Industry Code:**      Iron Foundries  
331511

**Detailed Code:**      Ductile iron fittings 14 in. or more  
3315111116



**Description of Subcomponent:**      These steel components serve as a means to support the rotor blades and secure them to the hub.

Source:  
<http://www.state.sd.us/puc/2000/Wind/Wind%20Word%20>

Typically weighing over a ton, each blade extender is mounted to a four-point ball bearing, which is then mounted to the hub. The structure of the extenders allows each blade maximize rotation while connected to the pitch mechanism.

## Brakes

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333613	Power Transmission Equip.	
<b>Detailed Code:</b> 3336133111	Friction-type Clutches and Brakes	
<b>Description of Subcomponent:</b>	Mechanical brakes are used as auxiliary devices to insure that the rotors, gears and generator have stopped during maintenance of periods of inclement weather.	Source: <a href="http://www.windpower.org/en/tour/wtrb/safety.htm">http://www.windpower.org/en/tour/wtrb/safety.htm</a>

The yaw mechanism typically halts any blade rotation by turning the rotors perpendicular to the wind direction. Should the rotors continue to turn, many turbines are equipped with either hydraulic or spring activated brake systems to prevent undesired rotation or fatigue on the turbine.

## Cooling System

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333412	Industrial and Commercial fans and blowers	
<b>Detailed Code:</b> 33341204	Axial fans	
<b>Description of Subcomponent:</b>	A large fan drives air to convectively cool the generator and gearbox and exhausts waste heat from the nacelle assembly. Ducting directs cool air to the generator.	Source: <a href="http://www.continentalfan.com/product.htm">http://www.continentalfan.com/product.htm</a>

Most wind turbines have cooling and dehumidifying units set to maintain conditions within the nacelle at levels such that rust and corrosion is largely prevented.

## Coupling

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333613	Power Transmission Equip.	
<b>Detailed Code:</b> 3336133329	Non-gear-type flexible couplings	
<b>Description of Subcomponent:</b>	The flexible coupling attaches to the high speed shaft and dampens out oscillating loads introduced by the gearbox. The reduction of these loads improves the quality of the electricity produced by the generator.	Source: <a href="http://www.mayr.de/english/p_old/sh_coup/roba_ds/roba_ds">http://www.mayr.de/english/p_old/sh_coup/roba_ds/roba_ds</a>

Modern couplings make use of composite materials for increased strength and flexibility. Use of these materials will increase and lighten the weight in a typical wind turbine.

## Electronic Controller

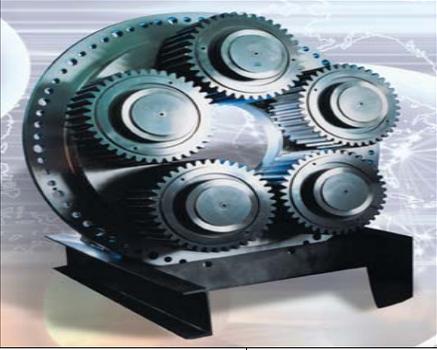
### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 334	Computer and Electronic Product Manufacturing	
<b>Industry Code:</b> 334418	Printed circuits and electronics assemblies	
<b>Detailed Code:</b> 334418A015	Industrial process control board assemblies	
<b>Description of Subcomponent:</b>	The communications subsystem allows the wind turbines to monitor themselves and report performance to a control station. The controller also adjusts blade pitch and turbine yaw to adapt to wind conditions.	Source: <a href="http://www.newenergy.org.cn/english/guide/control.htm">www.newenergy.org.cn/english/guide/control.htm</a>

Although there are typically controllers at the top and bottom of a tower, the increased data transfer capabilities of fiber optic wiring have provided the opportunity for a third controller to be placed in the hub of the rotor. The additional controller usually communicates with the nacelle unit using serial communications through a cable connected with slip rings and brushes on the main shaft.

## Gear Box

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333612	Speed Changer, Industrial	
<b>Detailed Code:</b> 3336127438	Enclosed concentric and parallel (Planetary) center distance 6 in. or more	
<b>Description of Subcomponent:</b>	The gearbox employs a planetary gear system to convert low-speed rotation of the input shaft from the rotor to high-speed rotation which drives the high-speed shaft of the generator assembly.	Source: <a href="http://www.machine design.com/ASP/viewSelectedArticle.as">http://www.machine design.com/ASP/viewSelectedArticle.as</a>

The gearboxes for larger wind turbines are more expensive per kilowatt (kW) of rated power than for smaller turbines because the torque increases more quickly than the power when increasing the rotor diameter. Hence, gearboxes have become one of the more expensive, critical components of a modern, utility-scale wind machine.

## Generator

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333611	Turbines, and Turbine Generators, and Turbine Generator Sets	
<b>Detailed Code:</b> 3336110871	Turbine generators	
<b>Description of Subcomponent:</b>	This system converts high-speed shaft work into electrical energy by spinning the rotor around the magnetic stator and using the electromagnetism to produce AC electricity.	Source: <a href="http://seattlepi.nwsource.com/photos/photo.asp?PhotoID=274">http://seattlepi.nwsource.com/photos/photo.asp?PhotoID=274</a>

Most modern wind turbines employ a doubly-fed, or induction, generator, which uses an electromagnet for both the stator and rotor magnets. This allows the generator to "slip" relative to the phasing of the electric grid, which both allows the wind turbine to operate at variable speed, as well as providing "reactive power" a feature which many utilities desire. However, this requires the use of power electronics to condition the generator output.

## Hub

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 331	Primary Metal Manufacturing	
<b>Industry Code:</b> 331511	Iron Foundries	
<b>Detailed Code:</b> 3315113221	Other ductile iron casting for all other uses	
<b>Description of Subcomponent:</b>	The hub serves as a base for the rotor blades and extenders, as well as a means of housing the control systems for the pitch drive. It rotates freely and attaches to the nacelle using a shaft and bearing assembly.	Source: <a href="http://www.richter-ag.de/english/highlights/windkraftanlage">http://www.richter-ag.de/english/highlights/windkraftanlage</a> .

The hub is often cast as a single steel part.

## Nacelle Case

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 326	Plastics and Rubber Products Manufacturing	
<b>Industry Code:</b> 326199	All Other Plastics Product Manufacturing	
<b>Detailed Code:</b> 326199A141	Other fabricated fiberglass and reinforced products	
<b>Description of Subcomponent:</b>	The nacelle case encloses all of the major mechanical components of the wind turbine.	Source: <a href="http://www.middelgrunden.dk/MG_UK/project_info/turbine.h">http://www.middelgrunden.dk/MG_UK/project_info/turbine.h</a>

The nacelle casing is composed of glass fiber-reinforced plastic with steel reinforcements. Through rubber dampers, the casing is mounted to the main frame with steel supports.

## Nacelle Frame

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 331	Primary Metal Manufacturing
<b>Industry Code:</b> 331511	Iron Foundries
<b>Detailed Code:</b> 3315113221	Other ductile iron casting for all other uses



<b>Description of Subcomponent:</b>	The nacelle frame is a steel bed to which all of the major components are bolted.
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Source:  
[www.cabinc.com/tgal.htm](http://www.cabinc.com/tgal.htm)

Numerous holes are drilled into the frame of the nacelle for stability reasons. While the largest hole allows maintenance entry through the bottom of the nacelle, the other holes are precisely placed in order to ensure that the frame will not vibrate in step with the other components of the turbine. The nacelle frame is a single cast steel piece.

## Pitch Drive

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing
<b>Industry Code:</b> 335312	Motors and Generators
<b>Detailed Code:</b> 33531230	Integral horsepower motors and generators other than for land transportation equip. (746 watts or more)



<b>Description of Subcomponent:</b>	This system controls the pitch of the blades to achieve the optimum angle for the wind speed and desired rotation speed.
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Source:  
[http://www.boschrexroth.com/BoschRexroth/business\\_units/b](http://www.boschrexroth.com/BoschRexroth/business_units/b)

For variable-pitch wind turbines, a drive system is used to change the pitch of the blades to vary power output, and at high wind speeds to divert excess energy, thus reducing stress on the blades and keeping rotational speeds within design specifications. There are typically three motors used to perform this function, one for each blade. A hydraulic power package in the nacelle provides the power, and in case of power failure, a hydraulic accumulator provides backup power for the system. Fully-electric pitch drives may also be employed.

## Power Electronics

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing	
<b>Industry Code:</b> 335999	Electronic Equipment and Components, NEC	
<b>Detailed Code:</b> 3359993219	Other rectifying(power conversion) apparatus, except for electronic circuitry	
<b>Description of Subcomponent:</b>	The power electronics match up the generator's output power with the electric grid.	Source: <a href="http://www.abb.com/global/abbzh/abbzh251.nsf!OpenData">http://www.abb.com/global/abbzh/abbzh251.nsf!OpenData</a>

With an induction generator (used in most modern wind turbines), the phase of the generator output must be synchronized to the phase of the utility grid. The power electronics do this by converting the AC signal from the generator to DC, and then re-inverting the DC back to AC at the correct phase.

## Rotor Blade

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 326	Plastics and Rubber Products Manufacturing	
<b>Industry Code:</b> 326199	All Other Plastics Product Manufacturing	
<b>Detailed Code:</b> 326199A141	Other fabricated fiberglass and reinforced products	
<b>Description of Subcomponent:</b>	Rotor blades convert the energy of the wind to mechanical energy by harnessing the principles of lift. Blades can have a stall regulated or variable-pitch design	Source: <a href="http://www.middelgrunden.dk/MG_UK/project_info/turbine.h">http://www.middelgrunden.dk/MG_UK/project_info/turbine.h</a>

Currently the majority of blades are made of glass fiber-reinforced plastic. The profile of the blade is carefully designed to maximize lift over the entire length of the blade, while still providing structural integrity in maximum wind conditions.

## Sensors/Data Loggers

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 334	Computer and Electronic Product Manufacturing	
<b>Industry Code:</b> 334519	Measuring and Controlling Devices	
<b>Detailed Code:</b> 3345197	Commercial, Meteorological, Geophysical, and General Purpose Instruments	
<b>Description of Subcomponent:</b>	Sensors throughout turbines relay information to the electronic controllers, which automatically adjust turbine components to address changing conditions.	<b>Source:</b> <a href="http://www.fraunhofer.de/german/press/pi/pi2003/09/md_fo2">http://www.fraunhofer.de/german/press/pi/pi2003/09/md_fo2</a> .

A wind vane measures wind direction and relays data to the yaw mechanism, a cable twist counter monitors cables within the tower to determine if the turbine has been yawing in one direction for an extended period of time, the anemometer measures wind speed. Additionally, a thermocouple senses temperature within the nacelle and a vibration sensor monitors vibration to detect potential component failure.

## Shafts

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333613	Power Transmission Equip.	
<b>Detailed Code:</b> 3336133792	Mechanical power transmission equipment, NEC, except parts	
<b>Description of Subcomponent:</b>	The low speed shaft connects the rotor to the input of the gearbox, and the high speed shaft connects the output of the gearbox to the generator.	<b>Source:</b> <a href="http://www.middelgrunden.dk/MG_UK/project_info/turbine.h">http://www.middelgrunden.dk/MG_UK/project_info/turbine.h</a>

The sizes of shafts have significantly decreased as component parts such as bearings have become smaller. Therefore, greater fatigue on smaller shafts has necessitated better handling of fatigue and possibly more regular maintenance.

## Tower Flange and Bolts

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 331	Primary Metal Manufacturing
<b>Industry Code:</b> 331511	Iron Foundries
<b>Detailed Code:</b> 3315111116	Ductile iron fittings 14 in. or more



**Description of Subcomponent:** These components join tower segments.

Source:  
[www.cabinc.com/tgal.htm](http://www.cabinc.com/tgal.htm)

A combination of bolting and welding is employed to join flanges and tower segments. To assure the stability of the tower welding seams, x-rays inspections are made of the adjoining segments.

## Towers

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 332	Fabricated Metal Product Manufacturing
<b>Industry Code:</b> 332312	Fabricated Structural Metal
<b>Detailed Code:</b> 3323125106	Fabricated structural iron and steel for transmission towers, radio antenna, and supporting structures



**Description of Subcomponent:** This large component of the turbine is made of rolled, tubular steel, and built in sections because of its size. For tubular towers, the most common type, a ladder is built in the hollow center to provide maintenance access.

Source:  
[http://www.middelgrunden.dk/MG\\_UK/project\\_info/turbine.h](http://www.middelgrunden.dk/MG_UK/project_info/turbine.h)

The size, both diameter and height, of the tower are restricted by transportation requirements.

## Yaw Drive

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing
<b>Industry Code:</b> 335312	Motors and Generators
<b>Detailed Code:</b> 33531230	Integral horsepower motors and generators other than for land transportation equip. (746 watts or more)



**Description of Subcomponent:** The yaw drive slews the turbine directly into the wind in order to generate maximum power. Typically, four yaw drives monitor the wind direction and active the yaw motors to face the prevailing wind.

Source:  
[http://www.boschrexroth.com/BoschRexroth/business\\_units/b](http://www.boschrexroth.com/BoschRexroth/business_units/b)

When the wind blows over 60 mph the mechanism turns 90 degrees from prevailing winds to reduce stress on internal components and to prevent stalling due to over-speed conditions.

## Solar Components

### Batteries

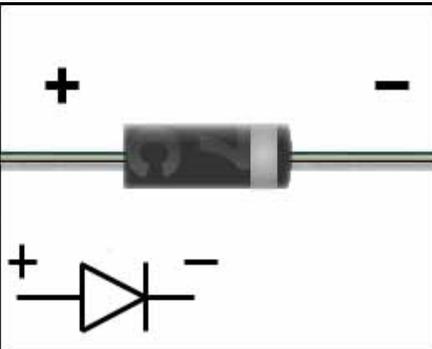
**NAICS Codes:**                      **NAICS Descriptions:**

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing		Source: <a href="http://www.nrel.gov/data/pix/Jpegs/11663.jpg">http://www.nrel.gov/data/pix/Jpegs/11663.jpg</a>
<b>Industry Code:</b> 335911	Storage Batteries		
<b>Detailed Code:</b> 3359114207	All other lead acid storage batteries, larger than BCI dimensional size group 8D (1.5 cu ft or .042 cu m and smaller), including starting, lighting, and ignition		
<b>Description of Subcomponent:</b>	The batteries are used to store the electricity produced by the solar module, and then to provide power during times of insufficient sun.		

For grid connected systems batteries can provide backup electricity in case of grid failure. For off-grid systems, batteries are necessary to provide energy during the night, or when it is cloudy and the sun is not shining. The vast majority of systems being installed currently are grid-tied, and batteries are only installed in approximately 2% of systems in the U.S. Given the nature of solar panels, only batteries designed for frequent charging and discharging (called deep-cycle batteries) will provide optimal performance. The most commonly used deep-cycle batteries are lead-acid and nickel-cadmium batteries.

### Blocking Diode

**NAICS Codes:**                      **NAICS Descriptions:**

<b>Subsector Code:</b> 334	Computer and Electronic Product Manufacturing		Source: <a href="http://mediatheek.thinkquest.nl/~kl010/elektro/diodes.JPG">http://mediatheek.thinkquest.nl/~kl010/elektro/diodes.JPG</a>
<b>Industry Code:</b> 334413	Semiconductors and Related Devices		
<b>Detailed Code:</b> 3344137015	Semiconductor rectifiers - power diodes and assemblies		
<b>Description of Subcomponent:</b>	The blocking diode is a semiconductor that keeps the battery from discharging through to the solar cells when there is no output from the cells to the battery.		

Blocking diodes are also referred to as "isolation diodes" when used to isolate cells from other cells in the array. This isolation allows the array to continue producing power when some of the cells are shaded.

## Charge Controller

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing
<b>Industry Code:</b> 335999	Electronic Equipment and Components, NEC
<b>Detailed Code:</b> 3359993104	Semiconductor battery chargers, industrial and railroad



**Description of Subcomponent:** The charge controller regulates the flow of electricity to and from the battery in order to charge efficiently, and to protect the batteries from overcharging.

Source:  
<http://www.nrel.gov/data/pix/Jpegs/06852.jpg>

Applying a charging current to an already full battery produces gases in the battery that build up pressure and can damage the battery. Also, a mismatch in the voltage output from the solar array and the charging requirements of the battery can reduce the charging efficiency - requiring more time to reach full charge. The charge controller regulates the voltage and current to charge the battery quickly and efficiently. It also detects when the battery is full and switches to a trickle charge mode, which maintains the battery's full state without causing damage. Like batteries, charge controllers are only used in about 2% of systems today, but are included in this report for completeness.

## Circuit Breakers and Fuses

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing
<b>Industry Code:</b> 335313	Switchgear and Switchboard Apparatus Manufacturing
<b>Detailed Code:</b> 3353131100	Power circuit breakers, all voltages



**Description of Subcomponent:** Both of these devices serve to protect the electronic circuitry, by breaking the connection to the system in the case of a current surge.

Source:  
<http://www.nrel.gov/data/pix/Jpegs/07792.jpg>

In a circuit breaker the current flows through an electromagnetic switch; when the current rises above a certain level the electromagnet pulls the switch, breaking the circuit. The circuit breaker can then be reset.

## Complete Module

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 334	Computer and Electronic Product Manufacturing	
<b>Industry Code:</b> 334413	Semiconductors and Related Devices	
<b>Detailed Code:</b> 334413A010	Photovoltaic modules	
<b>Description of Subcomponent:</b>	The module consists of the PV cells, top surface, encapsulant, substrate, rear layer and frame. A photovoltaic module is a complete unit ready to be mounted and connected to the electrical equipment.	Source: <a href="http://www.nrel.gov/data/pix/Jpegs/09059.jpg">http://www.nrel.gov/data/pix/Jpegs/09059.jpg</a>

A module typically consists of several cells, connected in a combination of serial and/or parallel connections to achieve the desired current-voltage characteristics. Multiple modules are often connected together to create the complete PV system.

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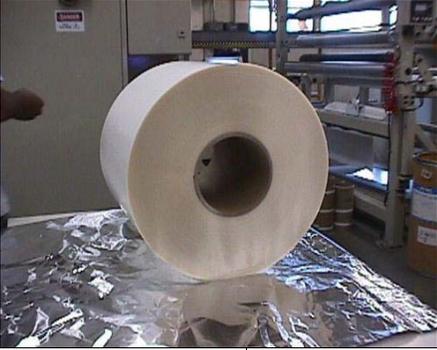
## Electrical Connections

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing	
<b>Industry Code:</b> 335931	Current-Carrying Wiring Device Manufacturing	
<b>Detailed Code:</b> 3359317100	Current-carrying metal contacts, including precious metal	
<b>Description of Subcomponent:</b>	Metal conductors carry electrons out of the cells, connecting the cells in the module in series or parallel, and carry electricity out of the module to the rest of the system.	Source: <a href="http://www.partsonsale.com/pw1000boxsmall.jpg">http://www.partsonsale.com/pw1000boxsmall.jpg</a>

## Encapsulant

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 325	Chemical Manufacturing		Source: <a href="http://www.nrel.gov/data/pix/Jpegs/13424.jpg">http://www.nrel.gov/data/pix/Jpegs/13424.jpg</a>
<b>Industry Code:</b> 325211	Plastics Material and Resin Manufacturing		
<b>Detailed Code:</b> 3252111160	Other thermoplastic resins and plastics materials		
<b>Description of Subcomponent:</b>	The encapsulant protects the cells, and holds together the top surface, PV cells and rear surface.		

Ethyl vinyl acetate (EVA) is the most common material used for the encapsulant. According to the Department of Energy, "thin sheets of EVA are inserted between the solar cells and the top and rear surfaces. Heating this "sandwich" causes the EVA to polymerize, thus bonding the module into one piece."

## Frame

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 332	Fabricated Metal Product Manufacturing		Source: <a href="http://www.nrel.gov/data/pix/Jpegs/13384.jpg">http://www.nrel.gov/data/pix/Jpegs/13384.jpg</a>
<b>Industry Code:</b> 332322	Sheet Metal Work Manufacturing		
<b>Detailed Code:</b> 332322G331	Other aluminum sheet metal work		
<b>Description of Subcomponent:</b>	The frame adds structure, and can attach to the mounting structure.		

Aluminum is a common material used for the frame. Thin-film modules are often flexible, having no frame, and are applied directly to the supporting structure. In building-integrated systems, the frame serves as roofing material and in other applications as well.

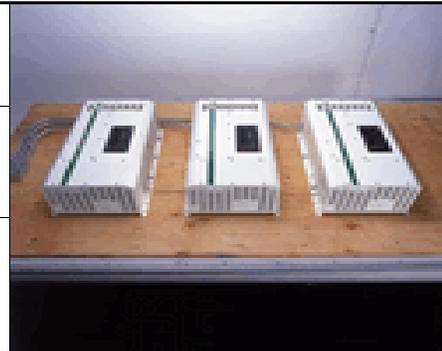
## Inverter

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Electrical Equipment, Appliance, and Component Manufacturing  
335

**Industry Code:** Electronic Equipment and Components, NEC  
335999

**Detailed Code:** Other rectifying (power conversion) apparatus (except for electronic circuitry)  
3359993219



**Description of Subcomponent:** The inverter converts direct-current (DC) electricity produced by the solar modules into alternating-current (AC) electricity to match the transmission grid.

Source:  
<http://www.nrel.gov/data/pix/Jpegs/10544.jpg>

Inverters are sophisticated electronic devices, and account for a large part of the balance of system cost in grid-connected PV systems. They must be able to synchronize to the grid and meet interconnection requirements, as well as provide power to AC equipment such as appliances in a typical residential installation.

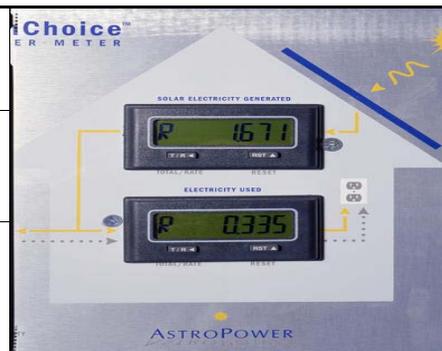
## Meter

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Computer and Electronic Product Manufacturing  
334

**Industry Code:** Instrument Manufacturing for Measuring and Testing Electricity and Electrical Signals  
334515

**Detailed Code:** Integrating instruments, electrical, demand meters, kW and kVA, combined watt-hour and demand meters (single phase and polyphase)  
3345151105



**Description of Subcomponent:** The meter is used particularly in grid connected systems to track the amount of energy produced by the PV system.

Source:  
<http://www.nrel.gov/data/pix/Jpegs/12244.jpg>

Some systems interface through a customer's existing utility meter, while others have additional equipment to display or report additional information or meet utility requirements.

## Rear Layer

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 326	Plastics and Rubber Products Manufacturing	
<b>Industry Code:</b> 326113	Unlaminated Plastics Film and Sheet (Except Packaging) Manufacturing	
<b>Detailed Code:</b> 3261130453	Other unlaminated plastics film and sheet	
<b>Description of Subcomponent:</b>	The rear layer protects the back surface of the module, and prevents water and gases from entering the module.	Source: <a href="http://www.fluortek.se/Old%20homepage/bilder/tedlarg.gif">http://www.fluortek.se/Old%20homepage/bilder/tedlarg.gif</a>

The rear layer must have low thermal resistance because the cell loses efficiency if its temperature is raised. Tedlar (a thin polymer sheet) is a common material for the rear layer.

## Solar cells

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 334	Computer and Electronic Product Manufacturing	
<b>Industry Code:</b> 334413	Semiconductors and Related Devices	
<b>Detailed Code:</b> 334413A005	Solar cells	
<b>Description of Subcomponent:</b>	A photovoltaic cell is any device that transforms light energy into electric energy. Current cells consist primarily of a semiconductor material, in which photons are absorbed from the incoming light to create free electrons.	Source: <a href="http://www.nrel.gov/data/pix/Jpegs/04065.jpg">http://www.nrel.gov/data/pix/Jpegs/04065.jpg</a>

Silicon solar cells are currently the most common, and can be single-crystal or multicrystalline. Single crystal silicon cells are the oldest commercial technology, and also the most efficient. Multicrystalline cells are less efficient due to grain boundaries between crystals blocking electron flow, but are also cheaper to produce. Amorphous silicon cells can be made in a thin, flexible film, making them ideal for building-integrated applications. They are less efficient than crystalline cells, and experience an initial decrease in performance, which later stabilizes. Thin-film cells made from copper indium diselenide (CIS) or cadmium telluride (CdTe) are also coming into use, because thin-film deposition can potentially be cheaper than silicon ingot growth. Several companies are also developing organic solar cells made using a dye-sensitizing process, or made from semiconducting polymers.

## Switch Gear

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing	
<b>Industry Code:</b> 335931	Current-Carrying Wiring Device Manufacturing	
<b>Detailed Code:</b> 3359315100	Current-carrying switches for electrical circuitry (including vehicular switches)	
<b>Description of Subcomponent:</b>	A number of switches are used to open and close the route that the electricity can flow through. Allows components of the system to be disconnected from one another.	Source: <a href="http://www.asa-schalttechnik.de/jpgs/prod_spe.jpg">http://www.asa-schalttechnik.de/jpgs/prod_spe.jpg</a>

The switches are important in order to disconnect the PV system from the grid when utility contractors are working on the grid line, to avoid risk of electrocution.

## Top surface

### NAICS Codes: NAICS Descriptions:

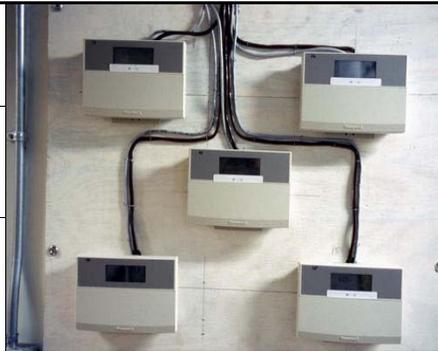
<b>Subsector Code:</b> 327	Nonmetallic Mineral Product Manufacturing	
<b>Industry Code:</b> 327211	Flat Glass	
<b>Detailed Code:</b> 3272111041	Flat glass, nonautomotive, other than pyrolytically coated, clear, less than 5.0 mm thick	
<b>Description of Subcomponent:</b>	The top surface allows light to enter the cell, while protecting the delicate cells from damage.	Source: <a href="http://www.sunarc.net/englisch/images/AR_Model01.jpg">http://www.sunarc.net/englisch/images/AR_Model01.jpg</a>

Based on the materials used for the cell, the necessary wavelengths need to be able to pass through the top surface. Reflection from the top surface should be minimized either by adding texture to the material, or adding an antireflection coating. The top cover needs to be resistant to weather damage including rain, hail, strong winds and ultraviolet radiation and needs to be strong enough to protect the inside of the module from damage. Generally made of glass or plastic.

## Wiring

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 331	Primary Metal Manufacturing
<b>Industry Code:</b> 331422	Copper Wire (except Mechanical) Drawing
<b>Detailed Code:</b> 3314224218	Copper apparatus wire and cord and flexible cord sets (except wiring harnesses and fiber optic), made in plants that draw wire



<b>Description of Subcomponent:</b>	Wiring is necessary for connecting the modules together into an array, and connecting the PV system to the utility grid or battery and load and controlling the movement of electricity.
-------------------------------------	--

Source:  
<http://www.nrel.gov/data/pix/Jpegs/13159.jpg>

## Geothermal Components

### Accumulator

#### NAICS Codes:      NAICS Descriptions:

**Subsector Code:**      Fabricated Metal Product Manufacturing  
332

**Industry Code:**      Metal Tank (Heavy Gauge) Manufacturing  
332420

**Detailed Code:**      Other pressure tanks (including anhydrous ammonia tanks), ferrous and nonferrous metal, complete at factory (standard line pressure)  
3324209111



**Description of Subcomponent:**      In a binary plant, the accumulator stores a quantity of working fluid in order to damp out pressure fluctuations and handle changes in flow rate.

Source:  
<http://www.unionsteel.co.kr/unihap/const/camera/4ccl/2001->

Typically a pressurized, steel vessel, 5,000 to 30,000 gallons depending on the capacity of the power plant and other variables.

### Air-cooled Condenser

#### NAICS Codes:      NAICS Descriptions:

**Subsector Code:**      Machinery Manufacturing  
333

**Industry Code:**      Industrial and Commercial fans and blowers  
333412

**Detailed Code:**      Industrial propeller fans directly connected to driver  
3334120573



**Description of Subcomponent:**      In most binary plants, a large radiator with forced-air convection provides cooling for the condensers.

Source:  
<http://www.geothermal.marin.org/GEO/presentation/images/>

Due to the lower temperatures of a binary plant, it is often more cost-effective to use air-cooling rather than evaporative cooling. The working fluid is sent through an array of horizontally-mounted radiator and fan units that blow air vertically over the radiators.

## Brine injection pump

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333911	Pump and Pumping Equipment Manufacturing	
<b>Detailed Code:</b> 333911148M	All other centrifugal pumps, over 6 in. discharge	
<b>Description of Subcomponent:</b>	The brine injection pump injects excess condensate and brine into the injection well at the pressure of the reservoir, in order to preserve the life of the reservoir.	Source: <a href="http://www.johnson-pump.com/">http://www.johnson-pump.com/</a>

The brine injection pump is a centrifugal pump, but may have to be made of a special alloy to handle the corrosive brine.

## Condensate Pump

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333911	Pump and Pumping Equipment Manufacturing	
<b>Detailed Code:</b> 333911148M	All other centrifugal pumps, over 6 in. discharge	
<b>Description of Subcomponent:</b>	The condensate pump pumps condensed geothermal fluid to the cooling tower to makeup lost cooling water.	Source: <a href="http://www.johnson-pump.com/">http://www.johnson-pump.com/</a>

This pump is a centrifugal pump.

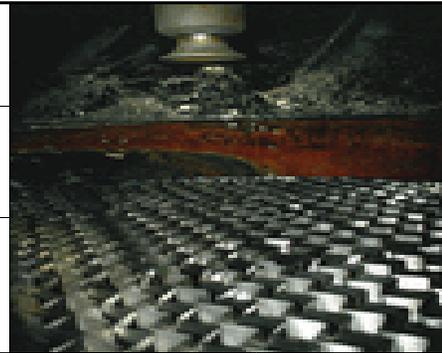
## Condenser

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Fabricated Metal Product Manufacturing  
332

**Industry Code:** Power Boiler and Heat Exchanger  
Manufacturing  
332410

**Detailed Code:** Fabricated steam condensers (except nuclear  
applications)  
3324101311



**Description of Subcomponent:** After expansion through the turbine, the condenser condenses the working or geothermal fluid to liquid phase. This creates a vacuum in the condenser, which improves the work output of the turbine.

Source:  
<http://www.nrel.gov/data/pix/Gifs/01573.gif>

Can be either "barometric" or "surface" type. In the barometric variety, cold water from the cooling tower is sprayed directly into the steam flow coming from the turbine, causing it to cool and condense to a liquid. The cooling water plus the condensate are pumped from the bottom of the condenser. The surface type is a shell-and-tube heat exchanger, with cooling water in tubes within a shell containing the steam. The steam condenses on contact with the cooled tubes, but the fluid streams do not mix.

## Cooling water pumps

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Machinery Manufacturing  
333

**Industry Code:** Pump and Pumping Equipment  
Manufacturing  
333911

**Detailed Code:** All other centrifugal pumps, over 6 in.  
discharge  
333911148M



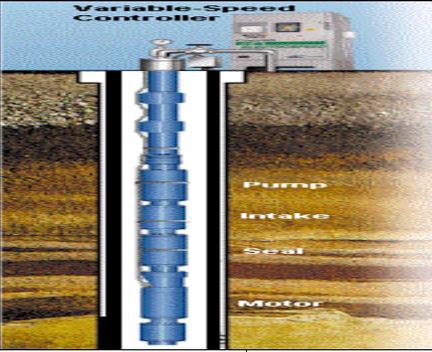
**Description of Subcomponent:** Circulating water pumps circulate cooling water in an evaporative cooling system, and a cooling water makeup pump replaces water that evaporates.

Source:  
<http://www.johnson-pump.com/>

Binary plants with an air cooled condenser (rather than an evaporative cooling tower) do not have a circulating cooling water pump. These pumps are typically centrifugal pumps.

## Downhole Pump

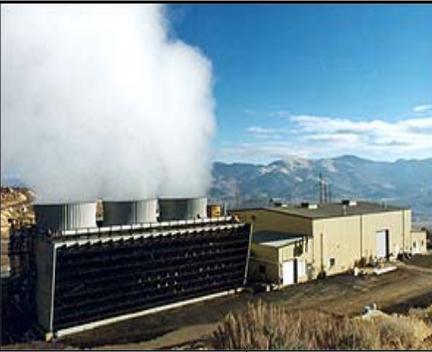
### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333911	Pump and Pumping Equipment Manufacturing	
<b>Detailed Code:</b> 3339111484	Centrifugal pumps, propeller and mixed flow, horizontal and vertical (including vertical turbine over 36 in.), over 36 in.	
<b>Description of Subcomponent:</b>	Downhole pumps are used in binary cycle plants to pump geothermal fluid out of the well.	Source: <a href="http://www.bakerhughes.com/centrilift/images/photos/New">http://www.bakerhughes.com/centrilift/images/photos/New</a>

Downhole pumps are required in lower temperature binary applications where the geothermal fluid does not have sufficient energy to self-flow. They are also used in applications where flashing of the geothermal fluid must be avoided, for example to prevent well sealing. In the past, pumps have typically been line-shaft pumps (with the motor above ground connected by a shaft to the pump), but recent improvements in submersible pumps have increased their use.

## Evaporative Cooling Tower

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333415	Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing	
<b>Detailed Code:</b> 3334159121	Evaporative air coolers	
<b>Description of Subcomponent:</b>	The cooling tower cools hot water coming from the condenser so it can be returned for re-use as cooling water.	Source: <a href="http://www.eere.energy.gov/geothermal/images/photo_07658">http://www.eere.energy.gov/geothermal/images/photo_07658</a>

Hot water coming from the outlet of the condenser is sprayed from nozzles, and a fan blows air through the spray. Some of the water evaporates, cooling the remaining liquid, which collects in a pool at the bottom and is pumped back to the condenser.

## Evaporator

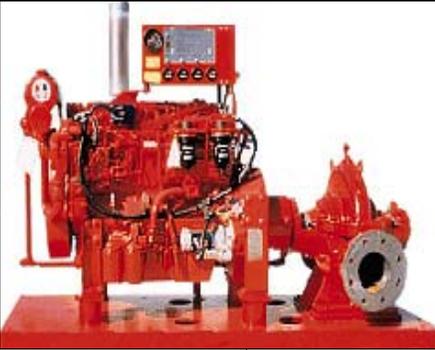
### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 332	Fabricated Metal Product Manufacturing	
<b>Industry Code:</b> 332410	Power Boiler and Heat Exchanger Manufacturing	
<b>Detailed Code:</b> 3324101206	Fabricated fin tube industrial heat exchangers, closed types (except nuclear applications)	
<b>Description of Subcomponent:</b>	The evaporator, or vaporiser, evaporates the working fluid in a binary plant.	Source:

This is typically a shell-and-tube heat exchanger, with hot geothermal fluid flowing through tubes within a shell, which contains the working fluid.

## Fire Water Pump

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333911	Pump and Pumping Equipment Manufacturing	
<b>Detailed Code:</b> 333911148M	All other centrifugal pumps, over 6 in. discharge	
<b>Description of Subcomponent:</b>	The fire water pump pumps pressurized water to the fire suppression sprinkler system.	Source: <a href="http://www.gormanrupp.com/products/pat/images/fire1pic.jpg">http://www.gormanrupp.com/products/pat/images/fire1pic.jpg</a>

The power plant buildings in a geothermal plant are required to have a fire suppression system of the overhead sprinkler type found in many buildings. Because the plants are typically not connected to a utility water system, a pump and tank is required to provide water for the fire system.

## Flash vessel

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 332	Fabricated Metal Product Manufacturing	
<b>Industry Code:</b> 332420	Metal Tank (Heavy Gauge) Manufacturing	
<b>Detailed Code:</b> 332420E106	Ferrous metal pressure tanks and vessels (more than 24 inch outside diameter and not less than 5 cu ft capacity), custom fabricated at the factory, for other processing industries	
<b>Description of Subcomponent:</b>	The flash vessel flashes some of the liquid fluid into steam by means of a sudden pressure drop.	Source: <a href="http://www.stelform.com.au/Thumbs/pv01_small4.jpg">http://www.stelform.com.au/Thumbs/pv01_small4.jpg</a>

It is a metal pressure vessel with an inlet for the two-phase fluid, an outlet at the top for steam, and an outlet on the bottom for brine. The incoming fluid expands to a lower pressure in the vessel, causing some of the fluid to flash to steam.

## Gantry Crane

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing	
<b>Detailed Code:</b> 3339233116	Gantry type overhead traveling cranes (except construction power cranes)	
<b>Description of Subcomponent:</b>	An overhead crane travels on the roof of the plant to lift and move heavy equipment.	Source: <a href="http://www.americancrane.com/assets/P0001932-sm.jpg">http://www.americancrane.com/assets/P0001932-sm.jpg</a>

The overhead gantry crane is essential in installing the heavy turbine-generator equipment in the power plant, as well as during operation and maintenance throughout the lifetime of the plant.

## Piping

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 331	Primary Metal Manufacturing	
<b>Industry Code:</b> 331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	
<b>Detailed Code:</b> 33121001H0	Alloy steel pipe and tubes, miscellaneous (including standard and structural)	
<b>Description of Subcomponent:</b>	The piping carries various fluids around the plant, including steam, brine, cooling water, and the working fluid in a binary plant.	Source: <a href="http://www.nrel.gov/data/pix/Jpegs/07208.jpg">http://www.nrel.gov/data/pix/Jpegs/07208.jpg</a>

Geothermal steam contains corrosive gases, and the pipes must be designed to withstand it. Often nickel-alloy or concrete-lined steel pipe is used.

## Silencer

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333132	Oil and Gas Field Machinery and Equipment Manufacturing	
<b>Detailed Code:</b> 3331325101	Oil and gas field production well Christmas tree assemblies (excluding subsea)	
<b>Description of Subcomponent:</b>	The silencer reduces noise due to the rapid expansion of steam to the atmosphere.	Source: <a href="http://e-trade.ktc.ksrp.or.jp/en/seeds/kitakyu/ima">http://e-trade.ktc.ksrp.or.jp/en/seeds/kitakyu/ima</a>

To start up the well before diverting fluid to the production lines, the well is vented to atmosphere through a silencer. Silencers are typically rock mufflers - a steel or concrete chamber filled with rock.

## Steam cyclone separator

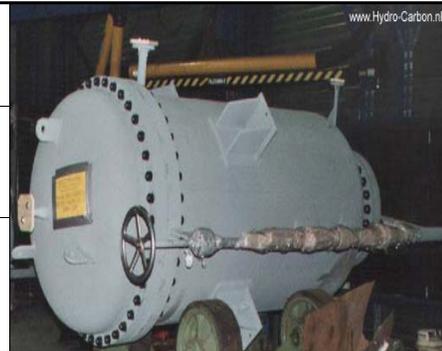
### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Fabricated Metal Product Manufacturing  
332

**Industry Code:** Metal Tank (Heavy Gauge) Manufacturing  
332420

**Detailed Code:** Ferrous metal pressure tanks and vessels (more than 24 inch outside diameter and not less than 5 cu ft capacity), custom fabricated at the factory, for other processing industries  
332420E106

**Description of Subcomponent:** The steam separator centrifugally separates liquid and steam from two-phase geothermal fluid



Source:  
<http://www.hydrocarbon.nl/img/cyclone/cyclone-2->

The fluid is injected tangentially into a cylindrical vessel, the liquid phase centrifuges to the outer wall and flows to the bottom. Low pressure created in the center of the vortex, causing the steam to flash and rise to the top, where it is withdrawn.

## Steam-jet Ejectors

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Machinery Manufacturing  
333

**Industry Code:** Air and Gas Compressor Manufacturing  
333912

**Detailed Code:** Vacuum pumps (compressors) (including value of the driver if shipped as a complete unit), except laboratory  
3339121220

**Description of Subcomponent:** The steam-jet ejectors remove noncondensable gases that would otherwise accumulate in the condenser.



Source:  
[http://www.artisanind.com/images/ejector\\_20.jpg](http://www.artisanind.com/images/ejector_20.jpg)

Because the condenser operates at a vacuum, a lower vacuum must be created to extract the NCGs. High pressure steam extracted upstream of the turbine is accelerated through a nozzle in the steam-jet ejector, creating a vacuum and entraining NCGs from the condenser. The steam/NCG mixture is then diffused to high pressure again, and usually condensed.

## Sulfur Plant

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** No Description Available

xxx

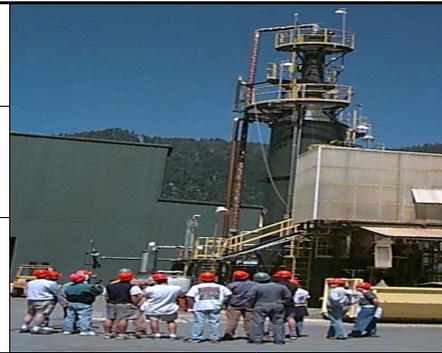
**Industry Code:** No NAICS Description

xxxxxx

**Detailed Code:**

**Description of Subcomponent:** The sulfur plant removes excess hydrogen sulfide from the NCG exhaust stream to comply with emission standards.

Source:  
<http://ekofisk.stanford.edu/geysers99/07.jpg>



Liquid redox sulfur plants are commonly used in geothermal plants because they are optimal for the low concentrations of H<sub>2</sub>S found in geothermal plant exhaust. The most common type of liquid redox is "chelated iron redox" in which ferric iron ions are held in solution by chelating agents and serve as electron donors and acceptors in the hydrogen sulfide redox reaction. This process is also desirable because it is efficient and produces innocuous byproducts.

## Turbine Generator Set

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Machinery Manufacturing

333

**Industry Code:** Turbines, and Turbine Generators, and Turbine Generator Sets

333611

**Detailed Code:** Turbine generator sets

3336110101

**Description of Subcomponent:** The turbine generator extracts energy from the geothermal fluid (or the working fluid in a binary cycle plant) by expansion through a series of blades.

Source:  
<http://www.geothermal.marin.org/GEOpresentation/images/>



Turbines consist of a series of blades that are made to rotate as the vapor expands through them. Steam turbines must be made of materials that can handle the corrosive gases, adding to their cost and complexity. In a dual-flash geothermal plant, the turbine will often have two inlets, one at the first stage of the turbine for the high pressure steam, and one at a later stage for lower pressure steam from the second flash system. In a binary plant, the turbine is designed for the working fluid that has been chosen, usually an organic hydrocarbon in an organic Rankine cycle plant, or an ammonia-water mixture for the Kalina cycle.

## Vacuum Pump

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333912	Air and Gas Compressor Manufacturing	
<b>Detailed Code:</b> 3339121277	Vacuum pumps (excluding laboratory), high vacuum, 29.6 in. mercury vacuum and over, 5 hp and over	
<b>Description of Subcomponent:</b>	In cases where a steam-jet ejector is not practical, a vacuum pump is used to remove noncondensable gases from the condenser.	Source: <a href="http://www.zbbz.com/en/images/cpzs/2bv2061.jpg">http://www.zbbz.com/en/images/cpzs/2bv2061.jpg</a>

## Well casing

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 331	Primary Metal Manufacturing	
<b>Industry Code:</b> 331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	
<b>Detailed Code:</b> 33121001H0	Alloy steel pipe and tubes, miscellaneous (including standard and structural)	
<b>Description of Subcomponent:</b>	The well casing is inserted into the well bore to provide structure and stability to the well hole.	Source:

For most geothermal applications, this is a welded steel pipe that forms the structural wall of the well bore.

## Wellhead valves and controls

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333132	Oil and Gas Field Machinery and Equipment Manufacturing	
<b>Detailed Code:</b> 3331325101	Oil and gas field production well Christmas tree assemblies (excluding subsea)	
<b>Description of Subcomponent:</b>	The wellhead assembly controls pressure and flow of the fluid exiting the geothermal well.	Source: <a href="http://www.geothermal.marin.org/GEO/presentation/images/">http://www.geothermal.marin.org/GEO/presentation/images/</a>

It is a collection of manual and automatic valves mounted to the head of the surface casing, consisting of master valve, crown valve, and side/wing valves.

## Working Fluid Pump

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333911	Pump and Pumping Equipment Manufacturing	
<b>Detailed Code:</b> 3339111484	Centrifugal pumps, propeller and mixed flow, horizontal and vertical (including vertical turbine over 36 in.), over 36 in.	
<b>Description of Subcomponent:</b>	In a binary plant, the working fluid pump pumps the condensed working fluid from the condenser back through the vaporizers.	Source: <a href="http://www.nrel.gov/data/pix/Jpegs/02209.jpg">http://www.nrel.gov/data/pix/Jpegs/02209.jpg</a>

These are typically vertical/can type pumps.

## Biomass Components

### Air Compressors

#### NAICS Codes:      NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333912	Air and Gas Compressor Manufacturing	
<b>Detailed Code:</b> 3339121166	Air compressors, new, stationary, centrifugal and axial	
<b>Description of Subcomponent:</b>	Air compressors provide pressurized air as required for various processes around the plant.	Source: <a href="http://www.meco-equipment.com/images/air-compressors-">http://www.meco-equipment.com/images/air-compressors-</a>

These are typically large, diesel-engine driven compressor units.

### Ash Handling System

#### NAICS Codes:      NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333922	Conveyor and Conveying Equipment Manufacturing	
<b>Detailed Code:</b> 3339228316	Bulk material handling pneumatic conveyors and conveying systems, except	
<b>Description of Subcomponent:</b>	The ash handling system collects ash from the precipitator and the boiler and transfers it to a storage location where it awaits removal from the plant.	Source: <a href="http://www.mecgale.com/flyash.html">http://www.mecgale.com/flyash.html</a>

Most of the ash is captured from the exhaust stream by the precipitator and/or cyclone. A large blower supplies sufficient air to convey the ash pneumatically from the precipitator and keep it fluidized as it flows through ducts to the storage location. Ash from the boiler is removed by a mechanical conveyor, either screw-type or drag-chain.

## Boiler Equipment

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 332	Fabricated Metal Product Manufacturing	
<b>Industry Code:</b> 332410	Power Boiler and Heat Exchanger Manufacturing	
<b>Detailed Code:</b> 3324105126	Water tube steel power boilers (stationary and marine), more than 15 p.s.i. steam working pressure, 100,001 lb per hour or more, saturated (except nuclear applications)	
<b>Description of Subcomponent:</b>	The boiler is the place where the biomass is burned, causing incoming water to boil and create steam.	

There are many different boiler designs, but the most common for biomass plants is a "spreader-stoker" boiler. A stoker, either mechanical or pneumatic, distributes the fuel as evenly as possible onto a grate, where the flame is sustained. Then a spreading mechanism, often either a traveling grate or a vibrating grate works to further distribute the fuel as well as to assist in ash removal. Overfire air is injected into the flue above the grate to ensure that all of the fuel is combusted. Heat and exhaust gases rise and flow over an array of tubes carrying the feedwater, which boils as a result of the heat transfer.

## Boiler Feed Pumps

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333911	Pump and Pumping Equipment Manufacturing	
<b>Detailed Code:</b> 333911146H	Centrifugal pumps, multistage, single or double suction, volute or diffuser design, axially split case, over 8 in. discharge	
<b>Description of Subcomponent:</b>	The boiler feed pumps pump water through the feedwater heaters and into the boiler.	Source: <a href="http://www.stiweb.com/applications/images/boiler_feed_pu">http://www.stiweb.com/applications/images/boiler_feed_pu</a>

These pumps are typically multi-stage centrifugal pumps. Reliability is of particular importance as these pumps must run continuously at high flow rates during the operation of the plant, and a failure of a feed pump could cause the plant to shut down temporarily.

## Boiler Feedwater System

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Fabricated Metal Product Manufacturing  
332

**Industry Code:** Industrial Valve Manufacturing  
332911

**Detailed Code:**



**Description of Subcomponent:** The boiler feedwater system controls the supply of water to the boiler to create steam.

Source:  
[http://www.becllusa.com/6\\_feed\\_water\\_pumps.html](http://www.becllusa.com/6_feed_water_pumps.html)

If the water level in the boiler becomes too low, the boiler is in danger of overheating and will shutdown. The feedwater system automatically monitors the water level in the boiler and adjusts the flow rate of the feedwater pumps to ensure a constant water level.

## Boiler Feedwater Tank

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Fabricated Metal Product Manufacturing  
332

**Industry Code:** Metal Tank (Heavy Gauge) Manufacturing  
332420

**Detailed Code:** Other ferrous metal nonpressure storage tanks, complete at factory (including tanks for trailers, metal septic tanks, etc.)  
332420C121



**Description of Subcomponent:** The feedwater tank stores the water that is supplied to the boiler to create steam.

Source:  
[http://www.becllusa.com/newsite/7\\_feed\\_water\\_storage.htm](http://www.becllusa.com/newsite/7_feed_water_storage.htm)

The tank must be sized large enough to ensure that sufficient water can be supplied for continuous operation of the plant.

## Boiler House Feed Conveyor

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333922	Conveyor and Conveying Equipment Manufacturing	
<b>Detailed Code:</b> 3339228101	Bulk material handling belt conveyors and conveying systems, except hoists and farm elevators	
<b>Description of Subcomponent:</b>	The boiler house conveyor transfers biomass fuel into the boiler.	Source: <a href="http://www.gtsenergy.com/products/solid_fuel/wood_fired.as">http://www.gtsenergy.com/products/solid_fuel/wood_fired.as</a>

Like the reclaim conveyor, this conveyor is also typically a belt-type continuous feed system.

## Breeching and Precipitator

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333411	Air Purification Equipment Manufacturing	
<b>Detailed Code:</b> 3334111110	Dust collection and other air purification equipment for industrial gas cleaning systems (for cleaning outgoing air), except parts	
<b>Description of Subcomponent:</b>	The breeching carries the flue gas out of the boiler, while the precipitator removes ash and other particulates from the gas.	Source: <a href="http://www.trimer.com/images/ccs-vs-electrostatic-">http://www.trimer.com/images/ccs-vs-electrostatic-</a>

The electrostatic precipitator is a pollution control device designed to remove particulates without creating a flow restriction like a filter would. It functions by creating an electrostatic field in the breeching which attracts particles to the electrode, which then flow by gravity into a collection bin.

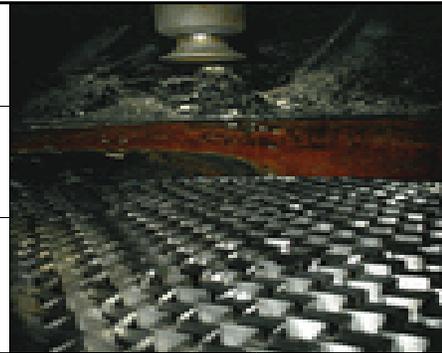
## Condenser

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Fabricated Metal Product Manufacturing  
332

**Industry Code:** Power Boiler and Heat Exchanger  
Manufacturing  
332410

**Detailed Code:** Fabricated steam condensers (except nuclear  
applications)  
3324101311



**Description of Subcomponent:** The condenser cools the steam exiting the turbine, causing to condense back to a liquid phase.

Source:  
<http://www.nrel.gov/data/pix/Gifs/01573.gif>

Condensing the steam after the turbine creates a vacuum in the condenser downstream of the turbine, allowing more energy extraction from the turbine. The condenser is essentially just a heat exchanger, transferring heat from the steam to the cooling water, which is then either re-cooled in a cooling tower, or returned to a source such as a river or lake.

## Cooling Tower

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Machinery Manufacturing  
333

**Industry Code:** Air-Conditioning and Warm Air Heating  
Equipment and Commercial and Industrial  
Refrigeration Equipment Manufacturing  
333415

**Detailed Code:** Evaporative air coolers  
3334159121



**Description of Subcomponent:** The cooling tower cools hot water coming from the condenser so it can be returned for re-use as cooling water.

Source:  
<http://www.nrel.gov/data/pix/Jpegs/06875.jpg>

Hot water coming from the outlet of the condenser is sprayed from nozzles, and a fan blows air through the spray. Some of the water evaporates, cooling the remaining liquid, which collects in a pool at the bottom and is pumped back to the condenser.

## Deaerating Feedwater Heater

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> Fabricated Metal Product Manufacturing 332	
<b>Industry Code:</b> Power Boiler and Heat Exchanger Manufacturing 332410	
<b>Detailed Code:</b> Fabricated bar tube industrial heat exchangers, closed types (except nuclear applications) 3324101101	
<b>Description of Subcomponent:</b> The deaerating feedwater heater removes noncondensable gases such as oxygen and carbon dioxide from the boiler feedwater.	Source: <a href="http://www.wabashpower.com/deaerator3.html">http://www.wabashpower.com/deaerator3.html</a>

Noncondensable gases can cause corrosion in pumps and piping if it is not removed. The deaerator works by spraying the water into a thin film and then heating to near the steam temperature. This causes the gases to come out of the liquid, without losing very much of the water to steam.

## Draft Equipment

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> Machinery Manufacturing 333	
<b>Industry Code:</b> Industrial and Commercial fans and blowers 333412	
<b>Detailed Code:</b>	
<b>Description of Subcomponent:</b>	Source: <a href="http://www.gravitaxim.com/Airpollution.htm">http://www.gravitaxim.com/Airpollution.htm</a>

## Dumper Hydraulic Unit

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333995	Fluid Power Cylinder and Actuator Manufacturing	
<b>Detailed Code:</b> 3339951100	Nonaerospace type hydraulic fluid power cylinders and actuators, linear and rotary	
<b>Description of Subcomponent:</b>	The dumper unit lifts the entire truck carrying a load of biomass fuel, causing the biomass to dump off the back of the truck.	Source: <a href="http://www.goldbell.com/chanpin/images/zcs-30-yfz.gif">http://www.goldbell.com/chanpin/images/zcs-30-yfz.gif</a>

This unit provides a quick and easy method of unloading incoming biomass supply from trucks.

## Equipment Insulation

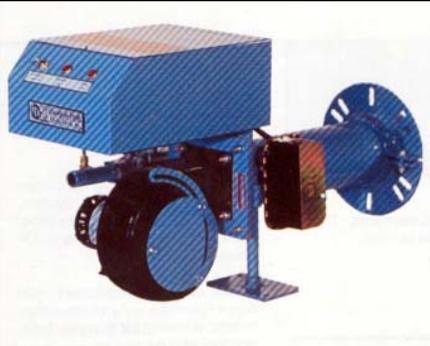
### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 327	Nonmetallic Mineral Product Manufacturing	
<b>Industry Code:</b> 327993	Mineral Wool Manufacturing	
<b>Detailed Code:</b> 3279934321	Mineral wool for industrial, equipment, and appliance pipe insulation	
<b>Description of Subcomponent:</b>	Most equipment and piping in the plant carrying high-temperature steam is insulated to reduce heat loss and improve the efficiency of the plant.	Source: <a href="http://www.koivet.com/heating/insulation2.jpg">http://www.koivet.com/heating/insulation2.jpg</a>

Glass or mineral wool is a common material for the insulation.

## Forced Draft Fan

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333412	Industrial and Commercial fans and blowers	
<b>Detailed Code:</b> 3334120324	Industrial centrifugal fans, excluding blowers, turboblowers, and multistage blowers	
<b>Description of Subcomponent:</b>	The draft fan forces air into the boiler to provide oxygen for combustion of the biomass fuel.	Source: <a href="http://www.wichitaburner.com/images/forceddraftgasburner.J">http://www.wichitaburner.com/images/forceddraftgasburner.J</a>

The fan is typically a large centrifugal blower. It must be sized appropriately to deliver the needed amount of air to complete the combustion process in the boiler.

## Front End Loaders

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333120	Construction Machinery Manufacturing	
<b>Detailed Code:</b> 3331201479	Wheel loaders, rear engine mount, integral design, 4-wheel drive, non-skid steer, 150 to 249 NEHP	
<b>Description of Subcomponent:</b>	Front end loaders are used to move biomass fuel into the storage pile.	Source: <a href="http://www.free-tractor-manuals.com/consu">http://www.free-tractor-manuals.com/consu</a>

They are common construction-site equipment, essentially a tractor with a hydraulically activated bucket mounted on the front.

## High Pressure Feedwater Heaters

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 332	Fabricated Metal Product Manufacturing	
<b>Industry Code:</b> 332410	Power Boiler and Heat Exchanger Manufacturing	
<b>Detailed Code:</b> 3324101101	Fabricated bar tube industrial heat exchangers, closed types (except nuclear applications)	
<b>Description of Subcomponent:</b>	The high pressure feedwater heater transfers heat from the steam exiting the high-pressure turbine stage into the feedwater.	Source: <a href="http://www.khei.com/product_tubular.html">http://www.khei.com/product_tubular.html</a>

Capturing excess heat from the turbine exhaust to raise the feedwater temperature reduces the heat required in the boiler to create steam, thus increasing the plant efficiency. The feedwater heater itself is a shell and tube heat exchanger, designed to handle the high-pressure steam.

## Induced Draft Fan

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333412	Industrial and Commercial fans and blowers	
<b>Detailed Code:</b> 3334120324	Industrial centrifugal fans, excluding blowers, turboblowers, and multistage blowers	
<b>Description of Subcomponent:</b>		Source: <a href="http://www.alternateheatingsystems.com/woodboilers.htm">http://www.alternateheatingsystems.com/woodboilers.htm</a>

## Instrumentation

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Computer and Electronic Product Manufacturing  
334

**Industry Code:** Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables  
334513

**Detailed Code:** Process control instruments  
3345130100



**Description of Subcomponent:** An array of instruments monitor and report to the operator of the plant the status of each component, and allow control of the plant.

Source:  
<http://www.nrel.gov/data/pix/Jpegs/03818.jpg>

Instrumentation could include pressure and temperature sensors, flow-rate sensors, and power meters, as well as controls for the boiler, the turbine generator and electrical equipment, and the various pumps and valves to control fluid flow.

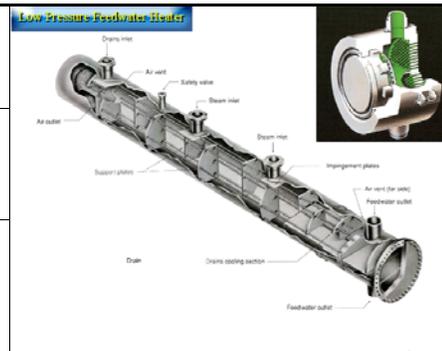
## Low Pressure Feedwater Heaters

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Fabricated Metal Product Manufacturing  
332

**Industry Code:** Power Boiler and Heat Exchanger Manufacturing  
332410

**Detailed Code:** Fabricated bar tube industrial heat exchangers, closed types (except nuclear applications)  
3324101101



**Description of Subcomponent:** Similar to the high pressure feedwater heater, the low-pressure feedwater heater transfers heat from the steam exiting the low-pressure turbine stage into the feedwater.

Source:  
<http://www.khei.com/images/Low-pressure-feedwater->

This heater is also a heat exchanger, but is simpler in design due to the lower pressure requirements.

## Main Transformer

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Electrical Equipment, Appliance, and Component Manufacturing  
335

**Industry Code:** Power, Distribution, and Specialty Transformer Manufacturing  
335311

**Detailed Code:** Commercial, institutional, and industrial general-purpose transformers, single- and three-phase, 100.01 kVA and above, all voltages  
3353117111



**Description of Subcomponent:** The main transformer steps up the voltage output of the power plant to match the high voltage of the transmission grid.

Source:  
<http://science.howstuffworks.com/power.htm/printable>

The transformer consists of an array of coils that step up the voltage from the 100s of volts range at which generators operate, to the 10 kV up to 100s of kVs at which transmission grids operate.

## Oil Burning Equipment

### NAICS Codes: NAICS Descriptions:

**Subsector Code:** Machinery Manufacturing  
333

**Industry Code:** Heating Equipment (except Warm Air Furnaces) Manufacturing  
333414

**Detailed Code:** Oil burners  
333414A101



**Description of Subcomponent:** The oil burner is used to start up the boiler after it has been shut down.

Source:  
<http://www.alternateheatingsystems.com/woodboilers.htm>

One or more oil burners located beneath the boiler grate create a flame in order to ignite the biomass during the initial start-up phase of boiler operation, and also to ensure that the entire boiler area is evenly ignited.

## Oil Storage Tank

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 332	Fabricated Metal Product Manufacturing	
<b>Industry Code:</b> 332420	Metal Tank (Heavy Gauge) Manufacturing	
<b>Detailed Code:</b> 332420C121	Other ferrous metal nonpressure storage tanks, complete at factory (including tanks for trailers, metal septic tanks, etc.)	
<b>Description of Subcomponent:</b>	The oil storage tank stores fuel oil for various uses in the plant.	Source: <a href="http://www.agrium.com/investmentrecovery/4404.jsp">http://www.agrium.com/investmentrecovery/4404.jsp</a>

It is a simple, unpressurized steel or aluminum tank.

## Other Water Pumps

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333911	Pump and Pumping Equipment Manufacturing	
<b>Detailed Code:</b> 333911146H	Centrifugal pumps, multistage, single or double suction, volute or diffuser design, axially split case, over 8 in. discharge units	
<b>Description of Subcomponent:</b>	Besides the main feedwater pumps, various other water pumps pump condensate from the condenser back to the beginning of the cycle, transfer make-up water from the supply source, provide service water, and circulate water at various points in the plant.	Source: <a href="http://www.americanlewa.com/PR-Condensate.htm">http://www.americanlewa.com/PR-Condensate.htm</a>

All of these pumps are typically multi-stage centrifugal pumps, with the drive motor attached directly to the pump.

## Piping

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 331	Primary Metal Manufacturing	
<b>Industry Code:</b> 331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel	
<b>Detailed Code:</b> 3312100100	Iron and steel pipes and tubes, made from purchased iron and steel	
<b>Description of Subcomponent:</b>	Piping carries steam and water between the various components of the plant.	

Almost all of the piping in the plant will be some type of steel, with some variation in thickness and type of alloy, depending on the pressure and temperature requirements of that particular section of piping.

## Reclaim Conveyor

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333922	Conveyor and Conveying Equipment Manufacturing	
<b>Detailed Code:</b> 3339228101	Bulk material handling belt conveyors and conveying systems, except hoists and farm elevators	
<b>Description of Subcomponent:</b>	The reclaim conveyor transfers biomass fuel from the storage pile to the power plant.	

The conveyor is a belt-type continuous conveyer.

## Switchgear

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 335	Electrical Equipment, Appliance, and Component Manufacturing	
<b>Industry Code:</b> 335313	Switchgear and Switchboard Apparatus Manufacturing	
<b>Detailed Code:</b> 335313A101	Switchgear (except ducts), automatic and manual control panels (generators, transformers, feed-controls, etc.)	
<b>Description of Subcomponent:</b>	The switchgear connects the power plant to the transformer, and the transformer to the grid.	Source: <a href="http://www.buhlerusa.com/AEWeb/Graphics/switchgear.jpg">http://www.buhlerusa.com/AEWeb/Graphics/switchgear.jpg</a>

The switchgear consists of manual and automatic switches and circuit breakers to isolate the plant components from the grid for maintenance, when the plant is not operating, or in case of a grid fault or other failure.

## Truck Scale

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333997	Scale and Balance (except Laboratory) Manufacturing	
<b>Detailed Code:</b> 3339971101	Motor truck scales	
<b>Description of Subcomponent:</b>	The truck scale is used to quantify the amount of biomass fuel being delivered to the plant by truck.	Source: <a href="http://www.samhing.com.hk/Truck.htm">http://www.samhing.com.hk/Truck.htm</a>

Trucks are weighed full when entering the plant, and then weighed empty upon leaving, the difference being equal to the mass of fuel delivered. This allows the plant to keep track of deliveries and to pay the suppliers for the fuel.

## Turbine Generator

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333611	Turbines, and Turbine Generators, and Turbine Generator Sets	
<b>Detailed Code:</b> 3336110101	Turbine generator sets	
<b>Description of Subcomponent:</b>	Steam expands and cools as it passes through a series of turbine blades, causing the turbine to rotate. The generator converts this rotational energy into electricity.	Source: <a href="http://www.becllcusa.com/10_steam_turbine_generators.htm">http://www.becllcusa.com/10_steam_turbine_generators.htm</a>

The turbine often has a high-pressure stage and a low pressure stage, with steam being fed to the feedwater pre-heaters in between stages. The final turbine stage feeds into the condenser, which is well below atmospheric pressure. The turbine is connected by a shaft to the generator, which is designed to run at a fixed RPM, in order to generate AC electricity that is in sync with the electric grid.

## Turbine Overhead Crane

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing	
<b>Detailed Code:</b> 3339233116	Gantry type overhead traveling cranes (except construction power cranes)	
<b>Description of Subcomponent:</b>	The overhead crane travels on the roof of the plant to lift and move heavy equipment.	Source: <a href="http://www.americancrane.com/assets/P0001932-sm.jpg">http://www.americancrane.com/assets/P0001932-sm.jpg</a>

The overhead gantry crane is essential in installing the heavy turbine-generator equipment in the power plant, as well as during operation and maintenance throughout the lifetime of the plant.

## Water Purification

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333999	All Other Miscellaneous General Purpose Machinery Manufacturing	
<b>Detailed Code:</b> 3339991104	Filter and strainer assemblies (containment or housing devices), with or without filter element installed, for water; except parts and accessories (except for fluid power systems)	
<b>Description of Subcomponent:</b>	The water purification system filters and purifies the water as it comes into the plant.	

Particulates and other matter in the incoming water could damage pumps and other equipment over time. The water purification system prevents this by filtering out particles over a certain size from the incoming water stream.

## Well Water Supply System

### NAICS Codes: NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333911	Pump and Pumping Equipment Manufacturing	
<b>Detailed Code:</b> 3339111440	Industrial pumps, except hydraulic fluid power pumps, automotive circulating pumps, and measuring and dispensing pumps	
<b>Description of Subcomponent:</b>	The well water system supplies make-up water to replace water lost to evaporation in the cooling tower.	Source: <a href="http://www.agioabadi.com/images/well_water1.jpg">http://www.agioabadi.com/images/well_water1.jpg</a>

This system consists primarily of a pump and piping to carry the water into the plant. A plant located on a river or lake would likely have a water supply system from the river or lake rather than from a well.

## Wood Handling

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 333	Machinery Manufacturing	
<b>Industry Code:</b> 333210	Sawmill and Woodworking Machinery Manufacturing	
<b>Detailed Code:</b> 3332103126	Other woodworking sawmill equipment	
<b>Description of Subcomponent:</b>	The wood handling system prepares fuel for use in the boiler.	Source: <a href="http://www.ec21.com/company/s/seungwoon/upimg/Wood_">http://www.ec21.com/company/s/seungwoon/upimg/Wood_</a>

The extent of the wood handling system depends on the quality of the fuel supply. For many plants, wood chips are provided in a form that is already almost ready for use. A grinding or hogging machine may be used to grind up oversized chips, and a magnet is used to remove stray metal.

## Woodchip Railcars

### NAICS Codes:            NAICS Descriptions:

<b>Subsector Code:</b> 336	Transportation Equipment Manufacturing	
<b>Industry Code:</b> 336510	Railroad Rolling Stock Manufacturing	
<b>Detailed Code:</b> 3365103100	Freight train and passenger train cars, new (excluding parts)	
<b>Description of Subcomponent:</b>	In some biomass plants, fuel is delivered via railcars.	Source: <a href="http://www.portofgraysharbor.com/photos/Train_WoodChip">http://www.portofgraysharbor.com/photos/Train_WoodChip</a>

The woodchip railcars are typically have an open top and enclosed sides, such as the kind also used for carrying gravel, coal or other bulk solids. This type of railroad car is also sometimes referred to as a "gondola" type car.

## **Appendix B – Complete List of Results for California Counties**

Appendix B consists of two tables listing all of the counties in California. The first table lists the number of firms operating in all relevant NAICS codes in each county, as well as the amount of manufacturing investment for each county that would result from the national development of each technology. The second table lists the firms in relevant NAICS codes again, and then shows the amount of job creation for each county resulting from the national development of each technology.

### Table of Contents:

Investment County Table .....	B2
Jobs County Table .....	B4

Location	# of Firms	Millions \$ Wind	Millions \$ Solar	Millions \$ Geothermal	Millions \$ Biomass	Total Millions \$
Alameda, CA	342	\$282.1	\$532.7	\$11.5	\$13.7	\$840.0
Alpine, CA	0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Amador, CA	4	\$4.2	\$10.6	\$0.0	\$0.2	\$15.0
Butte, CA	28	\$15.1	\$6.5	\$5.3	\$16.8	\$43.7
Calaveras, CA	5	\$0.8	\$0.3	\$0.0	\$0.0	\$1.1
Colusa, CA	0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Contra Costa,	82	\$44.0	\$79.4	\$1.9	\$7.3	\$132.6
Del Norte, CA	0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
El Dorado, CA	10	\$4.3	\$4.7	\$0.0	\$0.1	\$9.1
Fresno, CA	88	\$84.5	\$196.2	\$39.6	\$15.1	\$335.4
Glenn, CA	1	\$0.0	\$0.0	\$0.0	\$0.3	\$0.3
Humboldt, CA	11	\$8.6	\$1.4	\$0.0	\$0.1	\$10.1
Imperial, CA	5	\$2.2	\$0.0	\$0.0	\$0.0	\$2.2
Inyo, CA	2	\$0.5	\$0.0	\$0.0	\$0.0	\$0.5
Kern, CA	52	\$31.1	\$39.6	\$23.0	\$12.0	\$105.7
Kings, CA	10	\$2.4	\$15.2	\$0.8	\$5.3	\$23.7
Lake, CA	3	\$1.0	\$0.0	\$0.0	\$0.0	\$1.0
Lassen, CA	0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Los Angeles, CA	1,432	\$1,228.8	\$1,838.5	\$311.2	\$269.7	\$3,648.2
Madera, CA	13	\$2.3	\$0.1	\$5.9	\$2.2	\$10.5
Marin, CA	19	\$19.9	\$25.7	\$0.0	\$0.9	\$46.5
Mariposa, CA	1	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Mendocino, CA	20	\$2.8	\$3.0	\$0.0	\$2.6	\$8.4
Merced, CA	4	\$0.6	\$4.0	\$0.0	\$0.0	\$4.6
Modoc, CA	1	\$0.4	\$0.0	\$0.0	\$0.0	\$0.4
Mono, CA	2	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Monterey, CA	29	\$10.6	\$75.1	\$0.3	\$0.8	\$86.8
Napa, CA	26	\$24.1	\$30.9	\$8.4	\$4.3	\$67.7
Nevada, CA	12	\$4.4	\$0.9	\$0.0	\$0.5	\$5.8
Orange, CA	700	\$712.3	\$1,229.7	\$75.6	\$89.3	\$2,106.9
Placer, CA	41	\$14.0	\$138.6	\$0.2	\$0.4	\$153.2
Plumas, CA	1	\$0.0	\$0.3	\$0.0	\$0.0	\$0.3
Riverside, CA	206	\$150.6	\$290.0	\$8.0	\$13.6	\$462.2
Sacramento, CA	99	\$44.9	\$147.4	\$2.8	\$34.9	\$230.0
San Benito, CA	6	\$7.3	\$0.7	\$0.0	\$0.6	\$8.6
San Bernadino	286	\$291.9	\$377.2	\$22.2	\$26.3	\$717.6
San Diego, CA	434	\$948.7	\$781.3	\$816.3	\$276.6	\$2,822.9
San Francisco,	41	\$10.1	\$5.7	\$1.4	\$0.5	\$17.7
San Joaquin, CA	61	\$123.8	\$123.6	\$1.1	\$3.5	\$252.0
San Luis	33	\$15.8	\$4.6	\$3.8	\$4.4	\$28.6
San Mateo, CA	94	\$32.9	\$498.7	\$0.4	\$3.5	\$535.5
Santa Barbara,	60	\$28.5	\$61.6	\$5.2	\$7.5	\$102.8
Santa Clara,	635	\$623.1	\$5,139.3	\$295.2	\$108.3	\$6,165.9
Santa Cruz, CA	41	\$13.3	\$69.9	\$10.2	\$5.7	\$99.1
Shasta, CA	25	\$11.9	\$0.3	\$0.4	\$8.6	\$21.2
Sierra, CA	1	\$0.1	\$0.0	\$0.0	\$0.0	\$0.1
Siskiyou, CA	1	\$0.0	\$0.0	\$0.0	\$0.8	\$0.8
Solano, CA	45	\$39.1	\$2.7	\$19.3	\$58.1	\$119.2

<b>Location</b>	<b># of Firms</b>	<b>Millions \$ Wind</b>	<b>Millions \$ Solar</b>	<b>Millions \$ Geothermal</b>	<b>Millions \$ Biomass</b>	<b>Total Millions \$</b>
Sonoma, CA	101	\$38.8	\$67.7	\$40.7	\$46.4	\$193.6
Stanislaus, CA	47	\$41.2	\$3.1	\$1.3	\$13.4	\$59.0
Statewide, CA	0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Sutter, CA	7	\$12.4	\$0.0	\$0.0	\$0.0	\$12.4
Tehama, CA	5	\$3.1	\$0.4	\$0.0	\$0.0	\$3.5
Trinity, CA	0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Tulare, CA	28	\$54.5	\$83.0	\$2.2	\$6.6	\$146.3
Tuolumne, CA	9	\$3.7	\$0.1	\$0.0	\$0.2	\$4.0
Ventura, CA	178	\$173.7	\$366.4	\$17.5	\$26.4	\$584.0
Yolo, CA	19	\$29.5	\$2.6	\$0.7	\$1.9	\$34.7
Yuba, CA	3	\$3.0	\$0.8	\$0.0	\$0.0	\$3.8

<b>Location</b>	<b># of Firms</b>	<b>New Jobs Wind</b>	<b>New Jobs Solar</b>	<b>New Jobs Geothermal</b>	<b>New Jobs Biomass</b>	<b>Total New Jobs</b>
Alameda, CA	342	1,859	2,012	81	95	4,047
Alpine, CA	0	0	0	0	0	0
Amador, CA	4	27	69	0	1	97
Butte, CA	28	98	18	32	113	261
Calaveras, CA	5	5	3	0	0	8
Colusa, CA	0	0	0	0	0	0
Contra Costa,	82	284	420	10	45	759
Del Norte, CA	0	0	0	0	0	0
El Dorado, CA	10	33	36	0	1	70
Fresno, CA	88	540	880	229	93	1,742
Glenn, CA	1	0	0	0	1	1
Humboldt, CA	11	50	2	0	0	52
Imperial, CA	5	18	0	0	0	18
Inyo, CA	2	4	0	0	0	4
Kern, CA	52	188	158	159	82	587
Kings, CA	10	19	117	4	39	179
Lake, CA	3	8	0	0	0	8
Lassen, CA	0	0	0	0	0	0
Los Angeles, CA	1,432	7,816	8,955	1,413	1,662	19,846
Madera, CA	13	16	1	32	13	62
Marin, CA	19	131	155	0	6	292
Mariposa, CA	1	0	0	0	0	0
Mendocino, CA	20	21	20	0	17	58
Merced, CA	4	4	17	0	0	21
Modoc, CA	1	2	0	0	0	2
Mono, CA	2	0	0	0	0	0
Monterey, CA	29	69	238	2	6	315
Napa, CA	26	147	221	31	16	415
Nevada, CA	12	34	7	0	4	45
Orange, CA	700	4,914	6,546	445	603	12,508
Placer, CA	41	86	410	0	2	498
Plumas, CA	1	0	3	0	0	3
Riverside, CA	206	1,115	1,114	47	89	2,365
Sacramento, CA	99	290	407	12	237	946
San Benito, CA	6	43	6	0	4	53
San Bernadino	286	1,895	1,770	114	171	3,950
San Diego, CA	434	4,352	4,032	2,821	1,125	12,330
San Francisco,	41	54	21	7	2	84
San Joaquin, CA	61	752	561	7	24	1,344
San Luis	33	99	33	24	29	185
San Mateo, CA	94	225	2,234	3	22	2,484
Santa Barbara,	60	179	234	25	48	486
Santa Clara,	635	3,351	16,616	993	445	21,405
Santa Cruz, CA	41	92	191	56	37	376
Shasta, CA	25	78	3	2	59	142
Sierra, CA	1	1	0	0	0	1
Siskiyou, CA	1	0	0	0	6	6

<b>Location</b>	<b># of Firms</b>	<b>New Jobs Wind</b>	<b>New Jobs Solar</b>	<b>New Jobs Geothermal</b>	<b>New Jobs Biomass</b>	<b>Total New Jobs</b>
Solano, CA	45	252	16	128	412	808
Sonoma, CA	101	277	371	287	329	1,264
Stanislaus, CA	47	240	25	7	94	366
Statewide, CA	0	0	0	0	0	0
Sutter, CA	7	72	0	0	0	72
Tehama, CA	5	18	1	0	0	19
Trinity, CA	0	0	0	0	0	0
Tulare, CA	28	384	509	13	45	951
Tuolumne, CA	9	24	0	0	1	25
Ventura, CA	178	1,191	1,373	115	186	2,865
Yolo, CA	19	183	14	5	14	216
Yuba, CA	3	20	3	0	0	23

## **Appendix C – Detailed Results by NAICS for California Counties**

Appendix C consists of detailed information for each county in California. For each county there are four tables, one each for wind, solar, geothermal, and biomass listing the relevant NAICS codes for each technology. For each NAICS code, the table shows the number of firms in the county operating in that NAICS code, and the manufacturing investment and job creation resulting from the national development, for that particular NAICS Code and county. \*The counties are listed in alphabetical order.

\*Some counties in California were dropped from the NAICS for California due to zero activity.

## Alameda, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	19	\$89.6	514
326199	All Other Plastics Product Manufacturing	53	\$59.6	475
333612	Speed Changer, Industrial	4	\$41.4	280
335999	Electronic Equipment and Components, NEC	14	\$33.9	220
334519	Measuring and Controlling Devices	9	\$24.6	163
331511	Iron Foundries	6	\$21.3	150
334418	Printed circuits and electronics assemblies	15	\$8.4	36
333613	Power Transmission Equip.	1	\$1.6	10
335312	Motors and Generators	2	\$1.0	6
333412	Industrial and Commercial fans and blowers	3	\$0.7	5
<b>Total:</b>		126	\$282.1	1,859

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	39	\$326.9	829
335999	Electronic Equipment and Components, NEC	14	\$85.0	551
331422	Copper Wire (except Mechanical) Drawing	1	\$43.5	188
335931	Current-Carrying Wiring Device Manufacturing	2	\$25.6	195
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	6	\$14.1	56
334515	Instrument Manufacturing for Measuring and Testing	19	\$12.9	59
335911	Storage Batteries	1	\$7.8	41
332322	Sheet Metal Work Manufacturing	44	\$7.1	59
335313	Switchgear and Switchboard Apparatus Manufacturing	4	\$5.2	28
325211	Plastics Material and Resin Manufacturing	6	\$4.6	6
<b>Total:</b>		136	\$532.7	2,012

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333412	Industrial and Commercial fans and blowers	3	\$8.4	60
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$2.2	16
333923	Overhead Traveling Crane, Hoist, and Monorail System	3	\$0.4	2
333415	Air-Conditioning and Warm Air Heating Equipment and	5	\$0.3	2
333911	Pump and Pumping Equipment Manufacturing	1	\$0.1	1
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.1	0
333132	Oil and Gas Field Machinery and Equipment Manufacturing	1	\$0.0	0
<b>Total:</b>		15	\$11.5	81

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$7.5	53
333922	Conveyor and Conveying Equipment Manufacturing	5	\$1.7	11
335999	Electronic Equipment and Components, NEC	14	\$1.3	8
333412	Industrial and Commercial fans and blowers	3	\$1.1	8
333999	All Other Miscellaneous General Purpose Machinery	4	\$0.9	6
335313	Switchgear and Switchboard Apparatus Manufacturing	4	\$0.4	2
332911	Industrial Valve Manufacturing	3	\$0.3	2
333997	Scale and Balance (except Laboratory) Manufacturing	1	\$0.1	1
333923	Overhead Traveling Crane, Hoist, and Monorail System	3	\$0.1	1
333415	Air-Conditioning and Warm Air Heating Equipment and	5	\$0.1	1
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	2	\$0.1	1
334513	Instruments and Related Products Manufacturing for	12	\$0.1	1
327993	Mineral Wool Manufacturing	1	\$0.0	0
335311	Power, Distribution, and Specialty Transformer Manufacturing	2	\$0.0	0
333911	Pump and Pumping Equipment Manufacturing	1	\$0.0	0
333120	Construction Machinery Manufacturing	1	\$0.0	0
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	2	\$0.0	0
<b>Total:</b>		<b>65</b>	<b>\$13.7</b>	<b>95</b>

**Grand Total for Alameda, CA:**

**342      \$840.0      4,047**

## **Amador, CA**

### **Wind**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
335999	Electronic Equipment and Components, NEC	1	\$4.2	27
<b>Total:</b>		<b>1</b>	<b>\$4.2</b>	<b>27</b>

### **Solar**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
335999	Electronic Equipment and Components, NEC	1	\$10.5	68
332322	Sheet Metal Work Manufacturing	1	\$0.1	1
<b>Total:</b>		<b>2</b>	<b>\$10.6</b>	<b>69</b>

### **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
335999	Electronic Equipment and Components, NEC	1	\$0.2	1
<b>Total:</b>		<b>1</b>	<b>\$0.2</b>	<b>1</b>

**Grand Total for Amador, CA:**

**4      \$15.0      97**

## Butte, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	3	\$6.4	36
333613	Power Transmission Equip.	1	\$3.7	24
326199	All Other Plastics Product Manufacturing	3	\$3.4	27
331511	Iron Foundries	1	\$1.6	11
<b>Total:</b>		<b>8</b>	<b>\$15.1</b>	<b>98</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	1	\$5.6	14
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	2	\$0.9	4
332322	Sheet Metal Work Manufacturing	2	\$0.0	0
<b>Total:</b>		<b>5</b>	<b>\$6.5</b>	<b>18</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$2.2	16
333911	Pump and Pumping Equipment Manufacturing	1	\$1.8	10
333912	Air and Gas Compressor Manufacturing	1	\$1.1	5
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.2	1
<b>Total:</b>		<b>4</b>	<b>\$5.3</b>	<b>32</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$7.6	52
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$7.5	53
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.6	4
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	2	\$0.4	2
333911	Pump and Pumping Equipment Manufacturing	1	\$0.4	2
333120	Construction Machinery Manufacturing	1	\$0.1	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.1	0
333912	Air and Gas Compressor Manufacturing	1	\$0.1	0
333997	Scale and Balance (except Laboratory) Manufacturing	1	\$0.0	0
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.0	0
<b>Total:</b>		<b>11</b>	<b>\$16.8</b>	<b>113</b>

**Grand Total for Butte, CA:** **28** **\$43.7** **261**

## Calaveras, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
331511	Iron Foundries	1	\$0.8	5
<b>Total:</b>		1	\$0.8	5

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	3	\$0.3	3
<b>Total:</b>		3	\$0.3	3

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
<b>Total:</b>		1	\$0.0	0

**Grand Total for Calaveras, CA:** 5      \$1.1      8

## Contra Costa, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	2	\$18.0	117
332312	Fabricated Structural Metal	3	\$12.1	70
333612	Speed Changer, Industrial	1	\$5.0	34
334519	Measuring and Controlling Devices	6	\$5.0	33
326199	All Other Plastics Product Manufacturing	11	\$3.7	29
334418	Printed circuits and electronics assemblies	1	\$0.2	1
<b>Total:</b>		<b>24</b>	<b>\$44.0</b>	<b>284</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	2	\$45.2	293
334413	Semiconductors and Related Devices	4	\$21.5	55
334515	Instrument Manufacturing for Measuring and Testing	7	\$8.2	37
335931	Current-Carrying Wiring Device Manufacturing	2	\$2.3	18
332322	Sheet Metal Work Manufacturing	12	\$1.7	14
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.4	2
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	1	\$0.1	1
<b>Total:</b>		<b>29</b>	<b>\$79.4</b>	<b>420</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	1	\$1.8	10
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.1	0
<b>Total:</b>		<b>2</b>	<b>\$1.9</b>	<b>10</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$3.5	24
332911	Industrial Valve Manufacturing	8	\$2.2	13
335999	Electronic Equipment and Components, NEC	2	\$0.7	4
333911	Pump and Pumping Equipment Manufacturing	1	\$0.4	2
333999	All Other Miscellaneous General Purpose Machinery	3	\$0.3	2
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	3	\$0.1	0
333997	Scale and Balance (except Laboratory) Manufacturing	2	\$0.1	0
334513	Instruments and Related Products Manufacturing for	3	\$0.0	0
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.0	0
333120	Construction Machinery Manufacturing	1	\$0.0	0
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.0	0
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>27</b>	<b>\$7.3</b>	<b>45</b>

**Grand Total for Contra Costa, CA:** **82** **\$132.6** **759**

## El Dorado, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326199	All Other Plastics Product Manufacturing	4	\$3.6	29
332312	Fabricated Structural Metal	2	\$0.7	4
<b>Total:</b>		<b>6</b>	<b>\$4.3</b>	<b>33</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335931	Current-Carrying Wiring Device Manufacturing	1	\$4.7	36
334515	Instrument Manufacturing for Measuring and Testing	1	\$0.0	0
<b>Total:</b>		<b>2</b>	<b>\$4.7</b>	<b>36</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.1	1
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.0	0
<b>Total:</b>		<b>2</b>	<b>\$0.1</b>	<b>1</b>

<b>Grand Total for El Dorado, CA:</b>		<b>10</b>	<b>\$9.1</b>	<b>70</b>
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## Fresno, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	13	\$49.8	286
326199	All Other Plastics Product Manufacturing	11	\$19.1	152
335999	Electronic Equipment and Components, NEC	2	\$9.3	60
331511	Iron Foundries	2	\$4.0	28
335312	Motors and Generators	1	\$0.9	5
334519	Measuring and Controlling Devices	2	\$0.8	5
333412	Industrial and Commercial fans and blowers	1	\$0.6	4
<b>Total:</b>		32	\$84.5	540

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
327211	Flat Glass	2	\$169.2	701
335999	Electronic Equipment and Components, NEC	2	\$23.4	151
332322	Sheet Metal Work Manufacturing	9	\$3.2	26
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.4	2
<b>Total:</b>		14	\$196.2	880

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	3	\$29.9	160
333412	Industrial and Commercial fans and blowers	1	\$7.3	53
332420	Metal Tank (Heavy Gauge) Manufacturing	3	\$1.0	7
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$0.9	7
333912	Air and Gas Compressor Manufacturing	1	\$0.5	2
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
333132	Oil and Gas Field Machinery and Equipment Manufacturing	1	\$0.0	0
<b>Total:</b>		12	\$39.6	229

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333911	Pump and Pumping Equipment Manufacturing	3	\$6.8	37
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$3.1	22
333999	All Other Miscellaneous General Purpose Machinery	3	\$1.6	11
333412	Industrial and Commercial fans and blowers	1	\$0.9	7
332911	Industrial Valve Manufacturing	1	\$0.7	4
332420	Metal Tank (Heavy Gauge) Manufacturing	3	\$0.7	5
333922	Conveyor and Conveying Equipment Manufacturing	2	\$0.7	4
335999	Electronic Equipment and Components, NEC	2	\$0.4	2
333120	Construction Machinery Manufacturing	3	\$0.2	1
334513	Instruments and Related Products Manufacturing for	2	\$0.0	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.0	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
327993	Mineral Wool Manufacturing	3	\$0.0	0
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	1	\$0.0	0
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>30</b>	<b>\$15.1</b>	<b>93</b>
<b>Grand Total for Fresno, CA:</b>		<b>88</b>	<b>\$335.4</b>	<b>1,742</b>

## **Glenn, CA**

### **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
327993	Mineral Wool Manufacturing	1	\$0.3	1
<b>Total:</b>		<b>1</b>	<b>\$0.3</b>	<b>1</b>
<b>Grand Total for Glenn, CA:</b>		<b>1</b>	<b>\$0.3</b>	<b>1</b>

## Humboldt, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	3	\$8.1	46
326199	All Other Plastics Product Manufacturing	2	\$0.5	4
<b>Total:</b>		<b>5</b>	<b>\$8.6</b>	<b>50</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
325211	Plastics Material and Resin Manufacturing	1	\$1.4	2
332322	Sheet Metal Work Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>2</b>	<b>\$1.4</b>	<b>2</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
<b>Total:</b>		<b>1</b>	<b>\$0.0</b>	<b>0</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333120	Construction Machinery Manufacturing	2	\$0.1	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
<b>Total:</b>		<b>3</b>	<b>\$0.1</b>	<b>0</b>

<b>Grand Total for Humboldt, CA:</b>		<b>11</b>	<b>\$10.1</b>	<b>52</b>
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## Imperial, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326199	All Other Plastics Product Manufacturing	2	\$2.2	18
<b>Total:</b>		2	\$2.2	18

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
<b>Total:</b>		1	\$0.0	0

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
332911	Industrial Valve Manufacturing	1	\$0.0	0
<b>Total:</b>		2	\$0.0	0

**Grand Total for Imperial, CA:** 5 \$2.2 18

## Inyo, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326199	All Other Plastics Product Manufacturing	2	\$0.5	4
<b>Total:</b>		2	\$0.5	4

**Grand Total for Inyo, CA:** 2 \$0.5 4

## Kern, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	5	\$26.0	149
326199	All Other Plastics Product Manufacturing	5	\$3.5	28
333412	Industrial and Commercial fans and blowers	1	\$1.3	9
331511	Iron Foundries	1	\$0.3	2
<b>Total:</b>		<b>12</b>	<b>\$31.1</b>	<b>188</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
327211	Flat Glass	1	\$36.1	150
325211	Plastics Material and Resin Manufacturing	1	\$3.1	4
332322	Sheet Metal Work Manufacturing	4	\$0.4	4
<b>Total:</b>		<b>6</b>	<b>\$39.6</b>	<b>158</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333412	Industrial and Commercial fans and blowers	1	\$15.8	114
333911	Pump and Pumping Equipment Manufacturing	4	\$4.2	23
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$2.2	16
332420	Metal Tank (Heavy Gauge) Manufacturing	3	\$0.7	5
333132	Oil and Gas Field Machinery and Equipment Manufacturing	6	\$0.1	1
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
<b>Total:</b>		<b>16</b>	<b>\$23.0</b>	<b>159</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$7.5	53
333412	Industrial and Commercial fans and blowers	1	\$2.0	15
333911	Pump and Pumping Equipment Manufacturing	4	\$1.0	5
332420	Metal Tank (Heavy Gauge) Manufacturing	3	\$0.5	3
333999	All Other Miscellaneous General Purpose Machinery	3	\$0.5	3
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$0.3	2
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.2	1
332911	Industrial Valve Manufacturing	1	\$0.0	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
327993	Mineral Wool Manufacturing	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
<b>Total:</b>		<b>18</b>	<b>\$12.0</b>	<b>82</b>

**Grand Total for Kern, CA:** **52** **\$105.7** **587**

## **Kings, CA**

### **Wind**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
326199	All Other Plastics Product Manufacturing	2	\$2.4	19
<b>Total:</b>		2	\$2.4	19

### **Solar**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
335931	Current-Carrying Wiring Device Manufacturing	2	\$14.7	113
332322	Sheet Metal Work Manufacturing	3	\$0.5	4
<b>Total:</b>		5	\$15.2	117

### **Geothermal**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333911	Pump and Pumping Equipment Manufacturing	1	\$0.8	4
<b>Total:</b>		1	\$0.8	4

### **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333411	Air Purification Equipment Manufacturing	1	\$5.1	38
333911	Pump and Pumping Equipment Manufacturing	1	\$0.2	1
<b>Total:</b>		2	\$5.3	39

**Grand Total for Kings, CA:**

**10      \$23.7      179**

## **Lake, CA**

### **Wind**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
326199	All Other Plastics Product Manufacturing	2	\$1.0	8
<b>Total:</b>		2	\$1.0	8

### **Solar**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
332322	Sheet Metal Work Manufacturing	1	\$0.0	0
<b>Total:</b>		1	\$0.0	0

**Grand Total for Lake, CA:**

**3      \$1.0      8**

## Los Angeles, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	81	\$309.4	1,776
326199	All Other Plastics Product Manufacturing	263	\$308.3	2,455
335999	Electronic Equipment and Components, NEC	51	\$212.9	1,380
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	2	\$126.6	422
331511	Iron Foundries	16	\$86.6	607
333612	Speed Changer, Industrial	5	\$52.1	353
335312	Motors and Generators	25	\$49.0	298
334519	Measuring and Controlling Devices	31	\$41.6	275
332991	Ball and Roller Bearings	8	\$24.1	144
333613	Power Transmission Equip.	7	\$9.4	62
334418	Printed circuits and electronics assemblies	17	\$6.6	28
333412	Industrial and Commercial fans and blowers	4	\$2.2	16
<b>Total:</b>		510	\$1,228.8	7,816

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	51	\$534.1	3,463
335911	Storage Batteries	8	\$514.7	2,706
334413	Semiconductors and Related Devices	46	\$499.4	1,267
335931	Current-Carrying Wiring Device Manufacturing	14	\$67.0	512
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	33	\$64.4	255
325211	Plastics Material and Resin Manufacturing	27	\$40.5	55
332322	Sheet Metal Work Manufacturing	189	\$40.5	332
331422	Copper Wire (except Mechanical) Drawing	2	\$28.6	123
334515	Instrument Manufacturing for Measuring and Testing	40	\$28.2	128
335313	Switchgear and Switchboard Apparatus Manufacturing	17	\$21.1	114
<b>Total:</b>		427	\$1,838.5	8,955

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	2	\$175.5	585
332410	Power Boiler and Heat Exchanger Manufacturing	17	\$41.7	298
333412	Industrial and Commercial fans and blowers	4	\$26.9	194
333911	Pump and Pumping Equipment Manufacturing	21	\$26.4	141
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	9	\$15.1	54
333912	Air and Gas Compressor Manufacturing	11	\$10.9	47
332420	Metal Tank (Heavy Gauge) Manufacturing	18	\$8.7	62
333415	Air-Conditioning and Warm Air Heating Equipment and	30	\$4.1	21
333923	Overhead Traveling Crane, Hoist, and Monorail System	5	\$1.8	10
333132	Oil and Gas Field Machinery and Equipment Manufacturing	8	\$0.1	1
<b>Total:</b>		125	\$311.2	1,413

## Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332410	Power Boiler and Heat Exchanger Manufacturing	17	\$142.8	1,018
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	2	\$49.4	165
333922	Conveyor and Conveying Equipment Manufacturing	14	\$11.8	73
333999	All Other Miscellaneous General Purpose Machinery	49	\$11.1	77
335999	Electronic Equipment and Components, NEC	51	\$8.0	52
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	9	\$7.4	27
333911	Pump and Pumping Equipment Manufacturing	21	\$6.0	32
332420	Metal Tank (Heavy Gauge) Manufacturing	18	\$6.0	43
333210	Sawmill and Woodworking Machinery Manufacturing	4	\$4.9	34
332911	Industrial Valve Manufacturing	17	\$4.3	26
333411	Air Purification Equipment Manufacturing	4	\$3.7	27
333412	Industrial and Commercial fans and blowers	4	\$3.5	25
335311	Power, Distribution, and Specialty Transformer Manufacturing	14	\$2.5	14
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	9	\$2.1	14
335313	Switchgear and Switchboard Apparatus Manufacturing	17	\$1.6	9
333415	Air-Conditioning and Warm Air Heating Equipment and	30	\$1.6	8
334513	Instruments and Related Products Manufacturing for	33	\$1.3	8
333912	Air and Gas Compressor Manufacturing	11	\$0.6	3
333120	Construction Machinery Manufacturing	15	\$0.5	2
333923	Overhead Traveling Crane, Hoist, and Monorail System	5	\$0.4	3
333995	Fluid Power Cylinder and Actuator Manufacturing	21	\$0.1	1
333997	Scale and Balance (except Laboratory) Manufacturing	3	\$0.1	1
327993	Mineral Wool Manufacturing	1	\$0.0	0
336510	Railroad Rolling Stock Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>370</b>	<b>\$269.7</b>	<b>1,662</b>
<b>Grand Total for Los Angeles, CA:</b>		<b>1,432</b>	<b>\$3,648.2</b>	<b>19,846</b>

## Madera, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	2	\$1.4	8
326199	All Other Plastics Product Manufacturing	1	\$0.9	8
<b>Total:</b>		<b>3</b>	<b>\$2.3</b>	<b>16</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	1	\$0.1	1
<b>Total:</b>		<b>1</b>	<b>\$0.1</b>	<b>1</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333415	Air-Conditioning and Warm Air Heating Equipment and	2	\$3.3	17
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$2.3	13
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.3	2
<b>Total:</b>		<b>4</b>	<b>\$5.9</b>	<b>32</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333415	Air-Conditioning and Warm Air Heating Equipment and	2	\$1.3	7
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.6	3
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.2	2
327993	Mineral Wool Manufacturing	1	\$0.1	1
<b>Total:</b>		<b>5</b>	<b>\$2.2</b>	<b>13</b>

**Grand Total for Madera, CA:** **13** **\$10.5** **62**

## Marin, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	1	\$9.0	58
332312	Fabricated Structural Metal	2	\$6.0	34
326199	All Other Plastics Product Manufacturing	2	\$4.9	39
<b>Total:</b>		<b>5</b>	<b>\$19.9</b>	<b>131</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	1	\$22.6	147
334413	Semiconductors and Related Devices	2	\$2.8	7
334515	Instrument Manufacturing for Measuring and Testing	1	\$0.3	1
332322	Sheet Metal Work Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>5</b>	<b>\$25.7</b>	<b>155</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
<b>Total:</b>		<b>1</b>	<b>\$0.0</b>	<b>0</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333411	Air Purification Equipment Manufacturing	1	\$0.4	3
335999	Electronic Equipment and Components, NEC	1	\$0.3	2
332911	Industrial Valve Manufacturing	1	\$0.1	0
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.1	1
333120	Construction Machinery Manufacturing	1	\$0.0	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	2	\$0.0	0
<b>Total:</b>		<b>8</b>	<b>\$0.9</b>	<b>6</b>

**Grand Total for Marin, CA:** **19** **\$46.5** **292**

## Mariposa, CA

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332911	Industrial Valve Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>1</b>	<b>\$0.0</b>	<b>0</b>

**Grand Total for Mariposa, CA:** **1** **\$0.0** **0**

## Mendocino, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326199	All Other Plastics Product Manufacturing	2	\$2.1	17
332312	Fabricated Structural Metal	1	\$0.4	2
335999	Electronic Equipment and Components, NEC	1	\$0.3	2
<b>Total:</b>		<b>4</b>	<b>\$2.8</b>	<b>21</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	2	\$1.9	15
335999	Electronic Equipment and Components, NEC	1	\$0.8	5
325211	Plastics Material and Resin Manufacturing	1	\$0.3	0
<b>Total:</b>		<b>4</b>	<b>\$3.0</b>	<b>20</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
<b>Total:</b>		<b>1</b>	<b>\$0.0</b>	<b>0</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333999	All Other Miscellaneous General Purpose Machinery	2	\$1.9	13
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$0.3	2
335311	Power, Distribution, and Specialty Transformer Manufacturing	1	\$0.2	1
333120	Construction Machinery Manufacturing	2	\$0.2	1
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
335999	Electronic Equipment and Components, NEC	1	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	2	\$0.0	0
<b>Total:</b>		<b>11</b>	<b>\$2.6</b>	<b>17</b>

<b>Grand Total for Mendocino, CA:</b>		<b>20</b>	<b>\$8.4</b>	<b>58</b>
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## Merced, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	1	\$0.4	2
326199	All Other Plastics Product Manufacturing	1	\$0.2	2
<b>Total:</b>		<b>2</b>	<b>\$0.6</b>	<b>4</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	1	\$3.9	16
332322	Sheet Metal Work Manufacturing	1	\$0.1	1
<b>Total:</b>		<b>2</b>	<b>\$4.0</b>	<b>17</b>

**Grand Total for Merced, CA:** **4** **\$4.6** **21**

## Modoc, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	1	\$0.4	2
<b>Total:</b>		<b>1</b>	<b>\$0.4</b>	<b>2</b>

**Grand Total for Modoc, CA:** **1** **\$0.4** **2**

## Mono, CA

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>1</b>	<b>\$0.0</b>	<b>0</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>1</b>	<b>\$0.0</b>	<b>0</b>

**Grand Total for Mono, CA:** **2** **\$0.0** **0**

## Monterey, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	2	\$4.5	29
334519	Measuring and Controlling Devices	2	\$3.4	22
332312	Fabricated Structural Metal	2	\$1.4	8
326199	All Other Plastics Product Manufacturing	4	\$1.3	10
<b>Total:</b>		10	\$10.6	69

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	2	\$63.4	161
335999	Electronic Equipment and Components, NEC	2	\$11.2	73
335931	Current-Carrying Wiring Device Manufacturing	1	\$0.3	3
332322	Sheet Metal Work Manufacturing	2	\$0.2	1
334515	Instrument Manufacturing for Measuring and Testing	1	\$0.0	0
<b>Total:</b>		8	\$75.1	238

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.3	2
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
<b>Total:</b>		2	\$0.3	2

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$0.3	2
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.2	2
335999	Electronic Equipment and Components, NEC	2	\$0.2	1
334513	Instruments and Related Products Manufacturing for	3	\$0.1	1
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.0	0
<b>Total:</b>		9	\$0.8	6

<b>Grand Total for Monterey, CA:</b>		<b>29</b>	<b>\$86.8</b>	<b>315</b>
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## Napa, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	6	\$20.3	117
326199	All Other Plastics Product Manufacturing	4	\$3.5	28
333613	Power Transmission Equip.	1	\$0.3	2
<b>Total:</b>		<b>11</b>	<b>\$24.1</b>	<b>147</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335931	Current-Carrying Wiring Device Manufacturing	2	\$25.6	195
334515	Instrument Manufacturing for Measuring and Testing	2	\$4.1	19
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$1.0	5
332322	Sheet Metal Work Manufacturing	4	\$0.2	2
<b>Total:</b>		<b>9</b>	<b>\$30.9</b>	<b>221</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	1	\$8.1	29
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.3	2
<b>Total:</b>		<b>2</b>	<b>\$8.4</b>	<b>31</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	1	\$4.0	14
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.2	2
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.1	0
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
<b>Total:</b>		<b>4</b>	<b>\$4.3</b>	<b>16</b>

**Grand Total for Napa, CA:** **26** **\$67.7** **415**

## Nevada, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326199	All Other Plastics Product Manufacturing	3	\$4.2	33
334418	Printed circuits and electronics assemblies	1	\$0.2	1
<b>Total:</b>		<b>4</b>	<b>\$4.4</b>	<b>34</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	2	\$0.9	7
<b>Total:</b>		<b>2</b>	<b>\$0.9</b>	<b>7</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.4	3
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	2	\$0.1	1
333120	Construction Machinery Manufacturing	1	\$0.0	0
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
<b>Total:</b>		<b>6</b>	<b>\$0.5</b>	<b>4</b>

**Grand Total for Nevada, CA:** **12** **\$5.8** **45**

## Orange, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	22	\$224.3	1,454
326199	All Other Plastics Product Manufacturing	146	\$220.8	1,759
333612	Speed Changer, Industrial	6	\$137.1	928
332312	Fabricated Structural Metal	29	\$55.9	320
333613	Power Transmission Equip.	6	\$26.4	172
334418	Printed circuits and electronics assemblies	29	\$16.0	68
334519	Measuring and Controlling Devices	15	\$15.9	105
331511	Iron Foundries	6	\$11.3	79
335312	Motors and Generators	5	\$3.1	19
333412	Industrial and Commercial fans and blowers	2	\$1.2	8
332991	Ball and Roller Bearings	1	\$0.3	2
<b>Total:</b>		267	\$712.3	4,914

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	22	\$562.8	3,648
334413	Semiconductors and Related Devices	41	\$303.8	770
335911	Storage Batteries	2	\$133.4	701
335931	Current-Carrying Wiring Device Manufacturing	15	\$111.6	853
327211	Flat Glass	2	\$39.5	164
332322	Sheet Metal Work Manufacturing	81	\$22.7	186
334515	Instrument Manufacturing for Measuring and Testing	29	\$18.5	84
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	8	\$15.4	61
325211	Plastics Material and Resin Manufacturing	10	\$8.0	11
335313	Switchgear and Switchboard Apparatus Manufacturing	11	\$7.0	38
331422	Copper Wire (except Mechanical) Drawing	3	\$7.0	30
<b>Total:</b>		224	\$1,229.7	6,546

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	10	\$49.3	263
333412	Industrial and Commercial fans and blowers	2	\$14.6	105
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$4.7	34
332420	Metal Tank (Heavy Gauge) Manufacturing	4	\$3.3	23
333415	Air-Conditioning and Warm Air Heating Equipment and	9	\$3.0	16
333132	Oil and Gas Field Machinery and Equipment Manufacturing	3	\$0.3	2
333912	Air and Gas Compressor Manufacturing	1	\$0.2	1
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	2	\$0.1	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.1	1
<b>Total:</b>		33	\$75.6	445

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333411	Air Purification Equipment Manufacturing	6	\$28.8	213
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$16.1	115
333911	Pump and Pumping Equipment Manufacturing	10	\$11.3	60
335999	Electronic Equipment and Components, NEC	22	\$8.5	55
333999	All Other Miscellaneous General Purpose Machinery	31	\$7.9	55
332911	Industrial Valve Manufacturing	13	\$3.2	19
333922	Conveyor and Conveying Equipment Manufacturing	5	\$2.8	17
332420	Metal Tank (Heavy Gauge) Manufacturing	4	\$2.3	16
333412	Industrial and Commercial fans and blowers	2	\$1.9	14
335311	Power, Distribution, and Specialty Transformer Manufacturing	9	\$1.6	9
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	7	\$1.3	9
333415	Air-Conditioning and Warm Air Heating Equipment and	9	\$1.2	6
334513	Instruments and Related Products Manufacturing for	21	\$0.7	5
333210	Sawmill and Woodworking Machinery Manufacturing	3	\$0.7	5
335313	Switchgear and Switchboard Apparatus Manufacturing	11	\$0.5	3
327993	Mineral Wool Manufacturing	9	\$0.2	1
333997	Scale and Balance (except Laboratory) Manufacturing	1	\$0.1	1
333120	Construction Machinery Manufacturing	3	\$0.1	0
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	2	\$0.1	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	5	\$0.0	0
<b>Total:</b>		<b>176</b>	<b>\$89.3</b>	<b>603</b>
<b>Grand Total for Orange, CA:</b>		<b>700</b>	<b>\$2,106.9</b>	<b>12,508</b>

## Placer, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	6	\$8.7	50
335999	Electronic Equipment and Components, NEC	1	\$4.2	27
326199	All Other Plastics Product Manufacturing	5	\$1.1	9
<b>Total:</b>		<b>12</b>	<b>\$14.0</b>	<b>86</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	2	\$122.6	311
335999	Electronic Equipment and Components, NEC	1	\$10.5	68
334515	Instrument Manufacturing for Measuring and Testing	5	\$3.7	17
332322	Sheet Metal Work Manufacturing	4	\$1.3	11
335931	Current-Carrying Wiring Device Manufacturing	1	\$0.3	3
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.1	0
325211	Plastics Material and Resin Manufacturing	1	\$0.1	0
<b>Total:</b>		<b>15</b>	<b>\$138.6</b>	<b>410</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.1	0
333912	Air and Gas Compressor Manufacturing	1	\$0.1	0
333132	Oil and Gas Field Machinery and Equipment Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>3</b>	<b>\$0.2</b>	<b>0</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333999	All Other Miscellaneous General Purpose Machinery	2	\$0.2	1
335999	Electronic Equipment and Components, NEC	1	\$0.2	1
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	3	\$0.0	0
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.0	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
333120	Construction Machinery Manufacturing	2	\$0.0	0
<b>Total:</b>		<b>11</b>	<b>\$0.4</b>	<b>2</b>

<b>Grand Total for Placer, CA:</b>		<b>41</b>	<b>\$153.2</b>	<b>498</b>
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## Plumas, CA

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	1	\$0.3	3
<b>Total:</b>		1	\$0.3	3
<b>Grand Total for Plumas, CA:</b>		1	\$0.3	3

## Riverside, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326199	All Other Plastics Product Manufacturing	58	\$110.0	876
332312	Fabricated Structural Metal	11	\$32.0	184
335999	Electronic Equipment and Components, NEC	2	\$4.5	29
334519	Measuring and Controlling Devices	4	\$1.2	8
335312	Motors and Generators	3	\$1.1	6
331511	Iron Foundries	2	\$1.0	7
332991	Ball and Roller Bearings	2	\$0.7	4
334418	Printed circuits and electronics assemblies	2	\$0.1	1
<b>Total:</b>		<b>84</b>	<b>\$150.6</b>	<b>1,115</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	6	\$157.5	399
335911	Storage Batteries	1	\$93.5	491
335999	Electronic Equipment and Components, NEC	2	\$11.2	73
332322	Sheet Metal Work Manufacturing	23	\$8.0	66
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	2	\$7.9	31
325211	Plastics Material and Resin Manufacturing	4	\$4.8	7
335931	Current-Carrying Wiring Device Manufacturing	1	\$4.7	36
327211	Flat Glass	1	\$1.2	5
335313	Switchgear and Switchboard Apparatus Manufacturing	4	\$0.9	5
334515	Instrument Manufacturing for Measuring and Testing	1	\$0.3	1
<b>Total:</b>		<b>45</b>	<b>\$290.0</b>	<b>1,114</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332420	Metal Tank (Heavy Gauge) Manufacturing	3	\$3.8	27
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	3	\$2.4	9
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$0.9	7
333415	Air-Conditioning and Warm Air Heating Equipment and	8	\$0.8	4
333912	Air and Gas Compressor Manufacturing	1	\$0.1	0
<b>Total:</b>		<b>16</b>	<b>\$8.0</b>	<b>47</b>

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333999	All Other Miscellaneous General Purpose Machinery	11	\$3.9	27
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$3.1	22
332420	Metal Tank (Heavy Gauge) Manufacturing	3	\$2.6	19
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	3	\$1.2	4
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.6	4
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	3	\$0.6	4
333411	Air Purification Equipment Manufacturing	1	\$0.4	3
333415	Air-Conditioning and Warm Air Heating Equipment and	8	\$0.3	2
332911	Industrial Valve Manufacturing	3	\$0.2	2
333997	Scale and Balance (except Laboratory) Manufacturing	3	\$0.2	1
335999	Electronic Equipment and Components, NEC	2	\$0.2	1
335313	Switchgear and Switchboard Apparatus Manufacturing	4	\$0.1	0
333120	Construction Machinery Manufacturing	8	\$0.1	0
334513	Instruments and Related Products Manufacturing for	5	\$0.1	0
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	2	\$0.0	0
327993	Mineral Wool Manufacturing	2	\$0.0	0
<b>Total:</b>		<b>61</b>	<b>\$13.6</b>	<b>89</b>
<b>Grand Total for Riverside, CA:</b>		<b>206</b>	<b>\$462.2</b>	<b>2,365</b>

## Sacramento, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	9	\$22.8	131
326199	All Other Plastics Product Manufacturing	22	\$9.3	74
333612	Speed Changer, Industrial	1	\$5.0	34
333613	Power Transmission Equip.	1	\$3.7	24
334519	Measuring and Controlling Devices	4	\$3.1	21
334418	Printed circuits and electronics assemblies	2	\$0.6	3
335312	Motors and Generators	1	\$0.4	3
<b>Total:</b>		40	\$44.9	290

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	5	\$133.0	337
327211	Flat Glass	2	\$8.2	34
332322	Sheet Metal Work Manufacturing	26	\$3.6	30
325211	Plastics Material and Resin Manufacturing	2	\$1.5	2
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	2	\$1.1	4
334515	Instrument Manufacturing for Measuring and Testing	1	\$0.0	0
<b>Total:</b>		38	\$147.4	407

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333912	Air and Gas Compressor Manufacturing	1	\$2.4	10
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.4	2
333132	Oil and Gas Field Machinery and Equipment Manufacturing	1	\$0.0	0
<b>Total:</b>		3	\$2.8	12

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333411	Air Purification Equipment Manufacturing	1	\$25.7	191
336510	Railroad Rolling Stock Manufacturing	1	\$4.9	20
333922	Conveyor and Conveying Equipment Manufacturing	1	\$2.9	18
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$0.3	2
333999	All Other Miscellaneous General Purpose Machinery	4	\$0.3	2
333997	Scale and Balance (except Laboratory) Manufacturing	2	\$0.2	1
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.2	1
333912	Air and Gas Compressor Manufacturing	1	\$0.1	1
333120	Construction Machinery Manufacturing	3	\$0.1	0
332911	Industrial Valve Manufacturing	1	\$0.1	1
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.1	0
327993	Mineral Wool Manufacturing	1	\$0.0	0
<b>Total:</b>		18	\$34.9	237

<b>Grand Total for Sacramento, CA:</b>	<b>99</b>	<b>\$230.0</b>	<b>946</b>
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**San Benito, CA**

**Wind**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
332312	Fabricated Structural Metal	2	\$7.1	41
326199	All Other Plastics Product Manufacturing	1	\$0.1	1
334519	Measuring and Controlling Devices	1	\$0.1	1
<b>Total:</b>		<b>4</b>	<b>\$7.3</b>	<b>43</b>

**Solar**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
332322	Sheet Metal Work Manufacturing	1	\$0.7	6
<b>Total:</b>		<b>1</b>	<b>\$0.7</b>	<b>6</b>

**Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.6	4
<b>Total:</b>		<b>1</b>	<b>\$0.6</b>	<b>4</b>

<b>Grand Total for San Benito, CA:</b>	<b>6</b>	<b>\$8.6</b>	<b>53</b>
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## San Bernardino,

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	33	\$167.8	963
326199	All Other Plastics Product Manufacturing	84	\$82.4	656
335999	Electronic Equipment and Components, NEC	2	\$22.0	142
331511	Iron Foundries	3	\$10.4	73
334519	Measuring and Controlling Devices	7	\$4.3	29
333612	Speed Changer, Industrial	2	\$3.6	24
335312	Motors and Generators	1	\$0.9	5
334418	Printed circuits and electronics assemblies	1	\$0.4	2
332991	Ball and Roller Bearings	1	\$0.1	1
333412	Industrial and Commercial fans and blowers	1	\$0.0	0
<b>Total:</b>		135	\$291.9	1,895

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
327211	Flat Glass	1	\$181.5	752
335999	Electronic Equipment and Components, NEC	2	\$55.1	357
335911	Storage Batteries	2	\$47.7	251
331422	Copper Wire (except Mechanical) Drawing	1	\$43.5	188
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	7	\$20.1	80
332322	Sheet Metal Work Manufacturing	36	\$8.8	72
334413	Semiconductors and Related Devices	6	\$7.1	18
325211	Plastics Material and Resin Manufacturing	7	\$6.6	9
335931	Current-Carrying Wiring Device Manufacturing	3	\$3.9	29
335313	Switchgear and Switchboard Apparatus Manufacturing	3	\$2.1	11
334515	Instrument Manufacturing for Measuring and Testing	4	\$0.8	3
<b>Total:</b>		72	\$377.2	1,770

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	3	\$13.6	73
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	2	\$3.9	14
333415	Air-Conditioning and Warm Air Heating Equipment and	4	\$2.9	15
332420	Metal Tank (Heavy Gauge) Manufacturing	3	\$1.0	7
333412	Industrial and Commercial fans and blowers	1	\$0.5	4
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$0.2	1
333912	Air and Gas Compressor Manufacturing	1	\$0.1	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
333132	Oil and Gas Field Machinery and Equipment Manufacturing	1	\$0.0	0
<b>Total:</b>		17	\$22.2	114

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333411	Air Purification Equipment Manufacturing	4	\$12.7	94
333911	Pump and Pumping Equipment Manufacturing	3	\$3.1	17
333922	Conveyor and Conveying Equipment Manufacturing	5	\$2.0	12
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	2	\$1.9	7
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	4	\$1.5	10
333415	Air-Conditioning and Warm Air Heating Equipment and	4	\$1.1	6
335999	Electronic Equipment and Components, NEC	2	\$0.8	5
332420	Metal Tank (Heavy Gauge) Manufacturing	3	\$0.7	5
333999	All Other Miscellaneous General Purpose Machinery	6	\$0.6	4
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$0.5	4
336510	Railroad Rolling Stock Manufacturing	2	\$0.5	2
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$0.3	2
335313	Switchgear and Switchboard Apparatus Manufacturing	3	\$0.2	1
333120	Construction Machinery Manufacturing	6	\$0.2	1
333412	Industrial and Commercial fans and blowers	1	\$0.1	0
334513	Instruments and Related Products Manufacturing for	6	\$0.1	1
332911	Industrial Valve Manufacturing	1	\$0.0	0
327993	Mineral Wool Manufacturing	1	\$0.0	0
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	2	\$0.0	0
335311	Power, Distribution, and Specialty Transformer Manufacturing	2	\$0.0	0
333997	Scale and Balance (except Laboratory) Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>62</b>	<b>\$26.3</b>	<b>171</b>
<b>Grand Total for San Bernardino, CA:</b>		<b>286</b>	<b>\$717.6</b>	<b>3,950</b>

## San Diego, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	3	\$567.9	1,895
335999	Electronic Equipment and Components, NEC	18	\$153.5	995
332312	Fabricated Structural Metal	21	\$115.2	661
326199	All Other Plastics Product Manufacturing	83	\$56.5	450
335312	Motors and Generators	9	\$23.6	144
334519	Measuring and Controlling Devices	16	\$19.2	127
331511	Iron Foundries	2	\$4.0	28
333612	Speed Changer, Industrial	2	\$3.6	24
334418	Printed circuits and electronics assemblies	17	\$3.3	14
333412	Industrial and Commercial fans and blowers	3	\$1.8	13
332991	Ball and Roller Bearings	1	\$0.1	1
<b>Total:</b>		<b>175</b>	<b>\$948.7</b>	<b>4,352</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	18	\$385.2	2,498
334413	Semiconductors and Related Devices	24	\$215.9	548
334515	Instrument Manufacturing for Measuring and Testing	25	\$73.8	336
335911	Storage Batteries	3	\$38.3	201
335931	Current-Carrying Wiring Device Manufacturing	6	\$26.4	202
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	5	\$20.7	82
332322	Sheet Metal Work Manufacturing	52	\$19.4	159
331422	Copper Wire (except Mechanical) Drawing	1	\$1.5	6
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.1	0
<b>Total:</b>		<b>135</b>	<b>\$781.3</b>	<b>4,032</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	3	\$787.2	2,626
333412	Industrial and Commercial fans and blowers	3	\$21.9	158
333911	Pump and Pumping Equipment Manufacturing	4	\$5.2	28
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	2	\$0.9	3
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.4	3
333912	Air and Gas Compressor Manufacturing	2	\$0.3	1
333415	Air-Conditioning and Warm Air Heating Equipment and	5	\$0.3	1
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$0.1	1
<b>Total:</b>		<b>22</b>	<b>\$816.3</b>	<b>2,821</b>

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	3	\$221.7	740
333411	Air Purification Equipment Manufacturing	5	\$27.4	203
333999	All Other Miscellaneous General Purpose Machinery	14	\$8.9	62
335999	Electronic Equipment and Components, NEC	18	\$5.8	38
333210	Sawmill and Woodworking Machinery Manufacturing	4	\$5.0	34
333412	Industrial and Commercial fans and blowers	3	\$2.8	21
333922	Conveyor and Conveying Equipment Manufacturing	2	\$1.4	8
333911	Pump and Pumping Equipment Manufacturing	4	\$1.2	6
335311	Power, Distribution, and Specialty Transformer Manufacturing	4	\$0.7	4
334513	Instruments and Related Products Manufacturing for	22	\$0.6	4
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	2	\$0.4	2
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	4	\$0.2	1
333120	Construction Machinery Manufacturing	4	\$0.1	0
327993	Mineral Wool Manufacturing	2	\$0.1	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.1	1
333415	Air-Conditioning and Warm Air Heating Equipment and	5	\$0.1	1
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$0.1	0
333912	Air and Gas Compressor Manufacturing	2	\$0.0	0
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>102</b>	<b>\$276.6</b>	<b>1,125</b>
<b>Grand Total for San Diego, CA:</b>		<b>434</b>	<b>\$2,822.9</b>	<b>12,330</b>

## San Francisco, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	5	\$4.8	27
334418	Printed circuits and electronics assemblies	1	\$4.1	18
326199	All Other Plastics Product Manufacturing	5	\$0.9	7
331511	Iron Foundries	1	\$0.3	2
<b>Total:</b>		<b>12</b>	<b>\$10.1</b>	<b>54</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	3	\$3.2	8
335313	Switchgear and Switchboard Apparatus Manufacturing	2	\$1.1	6
334515	Instrument Manufacturing for Measuring and Testing	2	\$1.0	4
332322	Sheet Metal Work Manufacturing	7	\$0.3	2
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	1	\$0.1	1
<b>Total:</b>		<b>15</b>	<b>\$5.7</b>	<b>21</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	1	\$0.8	4
333912	Air and Gas Compressor Manufacturing	1	\$0.5	2
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.1	1
<b>Total:</b>		<b>3</b>	<b>\$1.4</b>	<b>7</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	1	\$0.2	1
332911	Industrial Valve Manufacturing	1	\$0.1	1
333120	Construction Machinery Manufacturing	1	\$0.1	0
335313	Switchgear and Switchboard Apparatus Manufacturing	2	\$0.1	0
327993	Mineral Wool Manufacturing	1	\$0.0	0
336510	Railroad Rolling Stock Manufacturing	1	\$0.0	0
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.0	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
<b>Total:</b>		<b>11</b>	<b>\$0.5</b>	<b>2</b>

**Grand Total for San Francisco, CA: 41 \$17.7 84**

## San Joaquin, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	10	\$96.3	552
326199	All Other Plastics Product Manufacturing	16	\$14.4	114
335999	Electronic Equipment and Components, NEC	1	\$9.0	58
331511	Iron Foundries	1	\$3.8	26
333613	Power Transmission Equip.	1	\$0.3	2
<b>Total:</b>		<b>29</b>	<b>\$123.8</b>	<b>752</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
327211	Flat Glass	1	\$84.6	350
335999	Electronic Equipment and Components, NEC	1	\$22.6	147
334413	Semiconductors and Related Devices	3	\$8.4	21
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	3	\$3.8	15
332322	Sheet Metal Work Manufacturing	7	\$2.1	17
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$2.1	11
334515	Instrument Manufacturing for Measuring and Testing	1	\$0.0	0
<b>Total:</b>		<b>17</b>	<b>\$123.6</b>	<b>561</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.7	5
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.2	1
333912	Air and Gas Compressor Manufacturing	1	\$0.2	1
<b>Total:</b>		<b>3</b>	<b>\$1.1</b>	<b>7</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333411	Air Purification Equipment Manufacturing	1	\$2.1	16
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.5	4
335999	Electronic Equipment and Components, NEC	1	\$0.3	2
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.2	1
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.2	1
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.1	0
333120	Construction Machinery Manufacturing	2	\$0.1	0
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
332911	Industrial Valve Manufacturing	1	\$0.0	0
327993	Mineral Wool Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>12</b>	<b>\$3.5</b>	<b>24</b>

**Grand Total for San Joaquin, CA:** **61** **\$252.0** **1,344**

## San Luis Obispo, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	4	\$7.8	45
334519	Measuring and Controlling Devices	1	\$6.6	44
326199	All Other Plastics Product Manufacturing	5	\$1.3	10
334418	Printed circuits and electronics assemblies	1	\$0.1	0
<b>Total:</b>		<b>11</b>	<b>\$15.8</b>	<b>99</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335931	Current-Carrying Wiring Device Manufacturing	1	\$2.0	15
332322	Sheet Metal Work Manufacturing	4	\$1.9	15
334515	Instrument Manufacturing for Measuring and Testing	1	\$0.7	3
<b>Total:</b>		<b>6</b>	<b>\$4.6</b>	<b>33</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	1	\$1.8	10
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$1.8	13
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.2	1
<b>Total:</b>		<b>4</b>	<b>\$3.8</b>	<b>24</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$1.2	9
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.8	6
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$0.7	5
332911	Industrial Valve Manufacturing	1	\$0.7	4
333911	Pump and Pumping Equipment Manufacturing	1	\$0.4	2
333411	Air Purification Equipment Manufacturing	1	\$0.4	3
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.1	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.1	0
334513	Instruments and Related Products Manufacturing for	2	\$0.0	0
335311	Power, Distribution, and Specialty Transformer Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>12</b>	<b>\$4.4</b>	<b>29</b>

<b>Grand Total for San Luis Obispo, CA:</b>		<b>33</b>	<b>\$28.6</b>	<b>185</b>
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## San Mateo, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	3	\$13.5	87
326199	All Other Plastics Product Manufacturing	19	\$10.9	87
332312	Fabricated Structural Metal	4	\$6.1	35
334519	Measuring and Controlling Devices	4	\$2.1	14
333613	Power Transmission Equip.	1	\$0.3	2
<b>Total:</b>		<b>31</b>	<b>\$32.9</b>	<b>225</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
331422	Copper Wire (except Mechanical) Drawing	1	\$437.7	1,887
335999	Electronic Equipment and Components, NEC	3	\$33.8	219
335313	Switchgear and Switchboard Apparatus Manufacturing	2	\$11.3	61
334413	Semiconductors and Related Devices	4	\$8.6	22
334515	Instrument Manufacturing for Measuring and Testing	5	\$4.1	19
332322	Sheet Metal Work Manufacturing	19	\$3.0	25
325211	Plastics Material and Resin Manufacturing	1	\$0.1	0
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	1	\$0.1	1
<b>Total:</b>		<b>36</b>	<b>\$498.7</b>	<b>2,234</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.2	1
333911	Pump and Pumping Equipment Manufacturing	1	\$0.1	1
333415	Air-Conditioning and Warm Air Heating Equipment and	2	\$0.1	1
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>5</b>	<b>\$0.4</b>	<b>3</b>

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
335311	Power, Distribution, and Specialty Transformer Manufacturing	2	\$0.9	5
335313	Switchgear and Switchboard Apparatus Manufacturing	2	\$0.9	5
333999	All Other Miscellaneous General Purpose Machinery	2	\$0.8	6
335999	Electronic Equipment and Components, NEC	3	\$0.5	3
333411	Air Purification Equipment Manufacturing	1	\$0.4	3
333911	Pump and Pumping Equipment Manufacturing	1	\$0.0	0
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.0	0
333120	Construction Machinery Manufacturing	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	3	\$0.0	0
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.0	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
333415	Air-Conditioning and Warm Air Heating Equipment and	2	\$0.0	0
332911	Industrial Valve Manufacturing	2	\$0.0	0
<b>Total:</b>		<b>22</b>	<b>\$3.5</b>	<b>22</b>
<b>Grand Total for San Mateo, CA:</b>		<b>94</b>	<b>\$535.5</b>	<b>2,484</b>

## Santa Barbara, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333613	Power Transmission Equip.	1	\$8.1	53
332312	Fabricated Structural Metal	5	\$7.5	43
326199	All Other Plastics Product Manufacturing	8	\$6.7	53
334418	Printed circuits and electronics assemblies	2	\$2.3	10
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	1	\$2.0	7
334519	Measuring and Controlling Devices	4	\$1.5	10
335312	Motors and Generators	2	\$0.3	2
333412	Industrial and Commercial fans and blowers	1	\$0.1	1
<b>Total:</b>		24	\$28.5	179

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	5	\$41.9	106
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$10.4	56
335931	Current-Carrying Wiring Device Manufacturing	3	\$8.6	66
332322	Sheet Metal Work Manufacturing	3	\$0.4	4
334515	Instrument Manufacturing for Measuring and Testing	2	\$0.3	2
<b>Total:</b>		14	\$61.6	234

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	1	\$2.7	9
333412	Industrial and Commercial fans and blowers	1	\$1.5	11
333911	Pump and Pumping Equipment Manufacturing	2	\$0.9	5
333912	Air and Gas Compressor Manufacturing	1	\$0.1	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
<b>Total:</b>		6	\$5.2	25

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333411	Air Purification Equipment Manufacturing	1	\$5.1	38
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	1	\$0.8	3
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.8	4
333911	Pump and Pumping Equipment Manufacturing	2	\$0.2	1
333999	All Other Miscellaneous General Purpose Machinery	2	\$0.2	1
333412	Industrial and Commercial fans and blowers	1	\$0.2	1
334513	Instruments and Related Products Manufacturing for	2	\$0.1	0
333120	Construction Machinery Manufacturing	2	\$0.1	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.0	0
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>16</b>	<b>\$7.5</b>	<b>48</b>
<b>Grand Total for Santa Barbara, CA:</b>		<b>60</b>	<b>\$102.8</b>	<b>486</b>

## Santa Clara, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	33	\$296.7	1,923
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	1	\$211.3	705
326199	All Other Plastics Product Manufacturing	40	\$37.6	300
334418	Printed circuits and electronics assemblies	50	\$32.8	139
334519	Measuring and Controlling Devices	19	\$31.2	206
332312	Fabricated Structural Metal	11	\$13.3	76
332991	Ball and Roller Bearings	1	\$0.1	1
335312	Motors and Generators	1	\$0.1	1
<b>Total:</b>		156	\$623.1	3,351

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	195	\$4,167.0	10,568
335999	Electronic Equipment and Components, NEC	33	\$744.4	4,826
334515	Instrument Manufacturing for Measuring and Testing	63	\$166.7	760
335931	Current-Carrying Wiring Device Manufacturing	8	\$29.4	224
332322	Sheet Metal Work Manufacturing	74	\$25.4	208
335313	Switchgear and Switchboard Apparatus Manufacturing	5	\$3.3	18
335911	Storage Batteries	1	\$1.3	7
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	2	\$0.9	4
325211	Plastics Material and Resin Manufacturing	2	\$0.9	1
<b>Total:</b>		383	\$5,139.3	16,616

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	1	\$292.9	977
332410	Power Boiler and Heat Exchanger Manufacturing	2	\$1.8	13
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$0.3	2
333912	Air and Gas Compressor Manufacturing	1	\$0.2	1
<b>Total:</b>		6	\$295.2	993

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333611	Turbines, and Turbine Generators, and Turbine Generator Sets	1	\$82.5	275
335999	Electronic Equipment and Components, NEC	33	\$11.2	73
332410	Power Boiler and Heat Exchanger Manufacturing	2	\$6.3	45
333999	All Other Miscellaneous General Purpose Machinery	7	\$4.5	31
335311	Power, Distribution, and Specialty Transformer Manufacturing	5	\$1.9	11
334513	Instruments and Related Products Manufacturing for	24	\$0.8	5
335313	Switchgear and Switchboard Apparatus Manufacturing	5	\$0.3	1
327993	Mineral Wool Manufacturing	2	\$0.3	1
332911	Industrial Valve Manufacturing	4	\$0.2	1
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$0.2	1
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.1	1
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	2	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>90</b>	<b>\$108.3</b>	<b>445</b>
<b>Grand Total for Santa Clara, CA:</b>		<b>635</b>	<b>\$6,165.9</b>	<b>21,405</b>

## Santa Cruz, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334519	Measuring and Controlling Devices	2	\$6.7	45
326199	All Other Plastics Product Manufacturing	7	\$4.2	33
332312	Fabricated Structural Metal	2	\$2.0	12
334418	Printed circuits and electronics assemblies	3	\$0.4	2
<b>Total:</b>		14	\$13.3	92

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	5	\$63.4	161
335911	Storage Batteries	1	\$3.7	20
334515	Instrument Manufacturing for Measuring and Testing	6	\$2.1	9
325211	Plastics Material and Resin Manufacturing	2	\$0.7	1
<b>Total:</b>		14	\$69.9	191

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	1	\$9.3	49
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$0.9	7
<b>Total:</b>		2	\$10.2	56

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$3.1	22
333911	Pump and Pumping Equipment Manufacturing	1	\$2.1	11
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.2	1
333999	All Other Miscellaneous General Purpose Machinery	2	\$0.2	2
334513	Instruments and Related Products Manufacturing for	6	\$0.1	1
<b>Total:</b>		11	\$5.7	37

<b>Grand Total for Santa Cruz, CA:</b>		<b>41</b>	<b>\$99.1</b>	<b>376</b>
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## Shasta, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	3	\$4.1	24
334519	Measuring and Controlling Devices	2	\$3.4	22
326199	All Other Plastics Product Manufacturing	3	\$2.2	17
333612	Speed Changer, Industrial	1	\$1.8	12
335312	Motors and Generators	1	\$0.4	3
<b>Total:</b>		<b>10</b>	<b>\$11.9</b>	<b>78</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	4	\$0.3	3
<b>Total:</b>		<b>4</b>	<b>\$0.3</b>	<b>3</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	1	\$0.3	1
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.1	1
333132	Oil and Gas Field Machinery and Equipment Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>3</b>	<b>\$0.4</b>	<b>2</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333210	Sawmill and Woodworking Machinery Manufacturing	1	\$7.6	52
333999	All Other Miscellaneous General Purpose Machinery	2	\$0.5	4
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.2	1
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased	1	\$0.2	1
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.1	1
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.0	0
327993	Mineral Wool Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>8</b>	<b>\$8.6</b>	<b>59</b>

**Grand Total for Shasta, CA:** **25** **\$21.2** **142**

## Sierra, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334519	Measuring and Controlling Devices	1	\$0.1	1
<b>Total:</b>		<b>1</b>	<b>\$0.1</b>	<b>1</b>

**Grand Total for Sierra, CA:** **1** **\$0.1** **1**

## Siskiyou, CA

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.8	6
<b>Total:</b>		1	\$0.8	6
<b>Grand Total for Siskiyou, CA:</b>		1	\$0.8	6

## Solano, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	5	\$26.7	153
326199	All Other Plastics Product Manufacturing	9	\$12.1	97
331511	Iron Foundries	1	\$0.3	2
<b>Total:</b>		15	\$39.1	252

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	2	\$1.8	15
325211	Plastics Material and Resin Manufacturing	3	\$0.9	1
<b>Total:</b>		5	\$2.7	16

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332410	Power Boiler and Heat Exchanger Manufacturing	2	\$15.8	112
333912	Air and Gas Compressor Manufacturing	1	\$2.4	10
333415	Air-Conditioning and Warm Air Heating Equipment and	2	\$1.1	6
<b>Total:</b>		5	\$19.3	128

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332410	Power Boiler and Heat Exchanger Manufacturing	2	\$54.0	385
333922	Conveyor and Conveying Equipment Manufacturing	2	\$1.5	9
333999	All Other Miscellaneous General Purpose Machinery	6	\$1.4	10
333411	Air Purification Equipment Manufacturing	1	\$0.4	3
333415	Air-Conditioning and Warm Air Heating Equipment and	2	\$0.4	2
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.3	2
333912	Air and Gas Compressor Manufacturing	1	\$0.1	1
333120	Construction Machinery Manufacturing	1	\$0.0	0
327993	Mineral Wool Manufacturing	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	2	\$0.0	0
333997	Scale and Balance (except Laboratory) Manufacturing	1	\$0.0	0
<b>Total:</b>		20	\$58.1	412

**Grand Total for Solano, CA:** **45** **\$119.2** **808**

## Sonoma, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326199	All Other Plastics Product Manufacturing	22	\$18.5	148
335999	Electronic Equipment and Components, NEC	6	\$12.0	78
332312	Fabricated Structural Metal	3	\$3.8	22
333412	Industrial and Commercial fans and blowers	1	\$3.0	21
335312	Motors and Generators	1	\$0.9	5
334418	Printed circuits and electronics assemblies	1	\$0.4	2
334519	Measuring and Controlling Devices	2	\$0.2	1
<b>Total:</b>		<b>36</b>	<b>\$38.8</b>	<b>277</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	6	\$30.0	195
334515	Instrument Manufacturing for Measuring and Testing	1	\$19.7	90
334413	Semiconductors and Related Devices	2	\$6.0	15
335931	Current-Carrying Wiring Device Manufacturing	1	\$4.7	36
327211	Flat Glass	1	\$3.4	14
332322	Sheet Metal Work Manufacturing	8	\$1.5	12
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$1.0	5
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	1	\$0.8	3
325211	Plastics Material and Resin Manufacturing	1	\$0.6	1
<b>Total:</b>		<b>22</b>	<b>\$67.7</b>	<b>371</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333412	Industrial and Commercial fans and blowers	1	\$36.9	266
333911	Pump and Pumping Equipment Manufacturing	1	\$1.8	10
333415	Air-Conditioning and Warm Air Heating Equipment and	3	\$1.0	5
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$0.9	6
333912	Air and Gas Compressor Manufacturing	1	\$0.1	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
<b>Total:</b>		<b>9</b>	<b>\$40.7</b>	<b>287</b>

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333411	Air Purification Equipment Manufacturing	2	\$26.1	193
333210	Sawmill and Woodworking Machinery Manufacturing	2	\$7.8	54
333412	Industrial and Commercial fans and blowers	1	\$4.8	35
333922	Conveyor and Conveying Equipment Manufacturing	2	\$3.1	19
333999	All Other Miscellaneous General Purpose Machinery	2	\$1.9	13
332420	Metal Tank (Heavy Gauge) Manufacturing	2	\$0.6	4
335999	Electronic Equipment and Components, NEC	6	\$0.5	3
333911	Pump and Pumping Equipment Manufacturing	1	\$0.4	2
333415	Air-Conditioning and Warm Air Heating Equipment and	3	\$0.4	2
335311	Power, Distribution, and Specialty Transformer Manufacturing	2	\$0.4	2
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	2	\$0.1	1
334513	Instruments and Related Products Manufacturing for	4	\$0.1	1
333997	Scale and Balance (except Laboratory) Manufacturing	1	\$0.1	0
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.1	0
333120	Construction Machinery Manufacturing	1	\$0.0	0
333923	Overhead Traveling Crane, Hoist, and Monorail System	1	\$0.0	0
333912	Air and Gas Compressor Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>34</b>	<b>\$46.4</b>	<b>329</b>
<b>Grand Total for Sonoma, CA:</b>		<b>101</b>	<b>\$193.6</b>	<b>1,264</b>

## Stanislaus, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	7	\$35.8	205
335312	Motors and Generators	1	\$4.4	27
326199	All Other Plastics Product Manufacturing	6	\$1.0	8
<b>Total:</b>		<b>14</b>	<b>\$41.2</b>	<b>240</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332322	Sheet Metal Work Manufacturing	12	\$3.1	25
<b>Total:</b>		<b>12</b>	<b>\$3.1</b>	<b>25</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	3	\$1.3	7
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>4</b>	<b>\$1.3</b>	<b>7</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333411	Air Purification Equipment Manufacturing	1	\$11.0	81
333922	Conveyor and Conveying Equipment Manufacturing	5	\$1.7	10
333911	Pump and Pumping Equipment Manufacturing	3	\$0.3	2
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.2	1
333997	Scale and Balance (except Laboratory) Manufacturing	1	\$0.1	0
334513	Instruments and Related Products Manufacturing for	1	\$0.1	0
333120	Construction Machinery Manufacturing	2	\$0.0	0
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.0	0
333995	Fluid Power Cylinder and Actuator Manufacturing	1	\$0.0	0
332911	Industrial Valve Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>17</b>	<b>\$13.4</b>	<b>94</b>

<b>Grand Total for Stanislaus, CA:</b>		<b>47</b>	<b>\$59.0</b>	<b>366</b>
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## Sutter, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	3	\$12.1	70
331511	Iron Foundries	1	\$0.3	2
<b>Total:</b>		<b>4</b>	<b>\$12.4</b>	<b>72</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333995	Fluid Power Cylinder and Actuator Manufacturing	2	\$0.0	0
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.0	0
<b>Total:</b>		<b>3</b>	<b>\$0.0</b>	<b>0</b>

**Grand Total for Sutter, CA:** **7** **\$12.4** **72**

## Tehama, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	2	\$3.1	18
334418	Printed circuits and electronics assemblies	1	\$0.0	0
<b>Total:</b>		<b>3</b>	<b>\$3.1</b>	<b>18</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	1	\$0.4	1
332322	Sheet Metal Work Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>2</b>	<b>\$0.4</b>	<b>1</b>

**Grand Total for Tehama, CA:** **5** **\$3.5** **19**

## Tulare, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	2	\$30.1	195
326199	All Other Plastics Product Manufacturing	7	\$21.9	175
332312	Fabricated Structural Metal	2	\$2.5	14
<b>Total:</b>		11	\$54.5	384

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
335999	Electronic Equipment and Components, NEC	2	\$75.6	490
334413	Semiconductors and Related Devices	1	\$5.6	14
325211	Plastics Material and Resin Manufacturing	1	\$1.4	2
332322	Sheet Metal Work Manufacturing	2	\$0.4	3
<b>Total:</b>		6	\$83.0	509

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333911	Pump and Pumping Equipment Manufacturing	1	\$1.8	10
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$0.4	3
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
<b>Total:</b>		3	\$2.2	13

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333411	Air Purification Equipment Manufacturing	1	\$2.1	16
332410	Power Boiler and Heat Exchanger Manufacturing	1	\$1.5	11
332911	Industrial Valve Manufacturing	1	\$1.5	9
335999	Electronic Equipment and Components, NEC	2	\$1.1	7
333911	Pump and Pumping Equipment Manufacturing	1	\$0.4	2
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
333922	Conveyor and Conveying Equipment Manufacturing	1	\$0.0	0
<b>Total:</b>		8	\$6.6	45

<b>Grand Total for Tulare, CA:</b>		<b>28</b>	<b>\$146.3</b>	<b>951</b>
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## Tuolumne, CA

### Wind

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
332312	Fabricated Structural Metal	2	\$2.5	14
326199	All Other Plastics Product Manufacturing	3	\$1.2	10
<b>Total:</b>		<b>5</b>	<b>\$3.7</b>	<b>24</b>

### Solar

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.1	0
<b>Total:</b>		<b>1</b>	<b>\$0.1</b>	<b>0</b>

### Biomass

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
333999	All Other Miscellaneous General Purpose Machinery	1	\$0.2	1
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.0	0
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
<b>Total:</b>		<b>3</b>	<b>\$0.2</b>	<b>1</b>

<b>Grand Total for Tuolumne, CA:</b>		<b>9</b>	<b>\$4.0</b>	<b>25</b>
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## Ventura, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326199	All Other Plastics Product Manufacturing	34	\$63.7	507
332312	Fabricated Structural Metal	9	\$31.2	179
335999	Electronic Equipment and Components, NEC	5	\$31.1	202
333613	Power Transmission Equip.	2	\$19.2	126
334519	Measuring and Controlling Devices	5	\$12.7	84
335312	Motors and Generators	2	\$12.3	75
334418	Printed circuits and electronics assemblies	8	\$2.4	10
333412	Industrial and Commercial fans and blowers	2	\$0.8	6
331511	Iron Foundries	1	\$0.3	2
<b>Total:</b>		<b>68</b>	<b>\$173.7</b>	<b>1,191</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
334413	Semiconductors and Related Devices	16	\$253.4	643
335999	Electronic Equipment and Components, NEC	5	\$78.1	507
335931	Current-Carrying Wiring Device Manufacturing	3	\$20.7	158
334515	Instrument Manufacturing for Measuring and Testing	6	\$6.9	32
332322	Sheet Metal Work Manufacturing	15	\$2.5	20
325211	Plastics Material and Resin Manufacturing	4	\$2.4	3
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	2	\$2.0	8
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.4	2
<b>Total:</b>		<b>52</b>	<b>\$366.4</b>	<b>1,373</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333412	Industrial and Commercial fans and blowers	2	\$10.4	75
333912	Air and Gas Compressor Manufacturing	3	\$2.9	13
332410	Power Boiler and Heat Exchanger Manufacturing	2	\$2.3	17
333911	Pump and Pumping Equipment Manufacturing	1	\$1.8	10
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.1	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
333132	Oil and Gas Field Machinery and Equipment Manufacturing	1	\$0.0	0
<b>Total:</b>		<b>11</b>	<b>\$17.5</b>	<b>115</b>

## **Biomass**

<b>NAICS</b>	<b>NAICS Description</b>	<b># of Firms in NAICS</b>	<b>Millions \$ Investmen</b>	<b>New FTE Jobs</b>
332410	Power Boiler and Heat Exchanger Manufacturing	2	\$8.0	57
333411	Air Purification Equipment Manufacturing	5	\$6.7	50
333999	All Other Miscellaneous General Purpose Machinery	10	\$4.3	30
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	3	\$3.5	23
333412	Industrial and Commercial fans and blowers	2	\$1.3	10
335999	Electronic Equipment and Components, NEC	5	\$1.2	8
327993	Mineral Wool Manufacturing	3	\$0.4	2
333911	Pump and Pumping Equipment Manufacturing	1	\$0.4	2
333922	Conveyor and Conveying Equipment Manufacturing	3	\$0.2	1
333912	Air and Gas Compressor Manufacturing	3	\$0.2	1
334513	Instruments and Related Products Manufacturing for	5	\$0.1	1
332911	Industrial Valve Manufacturing	1	\$0.1	1
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.0	0
333120	Construction Machinery Manufacturing	1	\$0.0	0
335313	Switchgear and Switchboard Apparatus Manufacturing	1	\$0.0	0
333415	Air-Conditioning and Warm Air Heating Equipment and	1	\$0.0	0
<b>Total:</b>		<b>47</b>	<b>\$26.4</b>	<b>186</b>
<b>Grand Total for Ventura, CA:</b>		<b>178</b>	<b>\$584.0</b>	<b>2,865</b>

## Yolo, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	2	\$15.7	90
333612	Speed Changer, Industrial	1	\$10.4	70
326199	All Other Plastics Product Manufacturing	2	\$2.1	17
334418	Printed circuits and electronics assemblies	1	\$1.0	4
334519	Measuring and Controlling Devices	1	\$0.3	2
<b>Total:</b>		<b>7</b>	<b>\$29.5</b>	<b>183</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	1	\$1.8	7
332322	Sheet Metal Work Manufacturing	2	\$0.8	7
<b>Total:</b>		<b>3</b>	<b>\$2.6</b>	<b>14</b>

### Geothermal

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.7	5
333132	Oil and Gas Field Machinery and Equipment Manufacturing	2	\$0.0	0
<b>Total:</b>		<b>3</b>	<b>\$0.7</b>	<b>5</b>

### Biomass

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
333999	All Other Miscellaneous General Purpose Machinery	2	\$0.8	6
332420	Metal Tank (Heavy Gauge) Manufacturing	1	\$0.5	4
332911	Industrial Valve Manufacturing	1	\$0.3	2
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing	1	\$0.3	2
334513	Instruments and Related Products Manufacturing for	1	\$0.0	0
<b>Total:</b>		<b>6</b>	<b>\$1.9</b>	<b>14</b>

**Grand Total for Yolo, CA:** **19** **\$34.7** **216**

## Yuba, CA

### Wind

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
332312	Fabricated Structural Metal	1	\$2.1	12
326199	All Other Plastics Product Manufacturing	1	\$0.9	8
<b>Total:</b>		<b>2</b>	<b>\$3.0</b>	<b>20</b>

### Solar

NAICS	NAICS Description	# of Firms in NAICS	Millions \$ Investmen	New FTE Jobs
326113	Unlaminated Plastics Film and Sheet (Except Packaging)	1	\$0.8	3
<b>Total:</b>		<b>1</b>	<b>\$0.8</b>	<b>3</b>

**Grand Total for Yuba, CA:** **3** **\$3.8** **23**

## **Appendix D - Identifying Potential Supply Bottlenecks**

Potential supply bottlenecks data was compiled from the following U.S. Census Bureau, 2002 Economic Census Industry Series Reports – Manufacturing (NAICS Codes) and the 2004 Survey of Plant Capacity (MQ-C1(04)).

To identify potential bottlenecks in the component supply chain we first established for each NAICS code the current production capacity, compared that to the maximum available production capacity. For each NAICS code we established an Available Production Capacity. Available Production Capacity is compared to the Incremental Demand for parts from that NAICS code. The Incremental Demand is the annual demand related to the installation of the wedge of 18,500 MW. If the Incremental Demand is greater than the total Available Production Capacity, there is a strong chance of a bottleneck developing. Identifying these bottlenecks should be met with a concerted effort to begin building industrial capacity to avoid the bottleneck.

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**Demand for Wind Components as % of Available Production Capacity: 124900 MW**

	Wind 10 Digit NAICS Codes	NAICS Code Description	Current Industrial Output	Industrial Output at 100% Capacity Utilization	Available Production Capacity	% of Full Production Capacity for Specific 6 digit NAICS	Total Product Shipments Value (\$1000) for 6 digit NAICS Code	% of Full Production Capacity Utilization Rates	Market Value (\$1000) of Total Production at full capacity for 6 digit NAICS Code
326199A141	Nacelle Case	Other fabricated fiberglass and reinforced products	\$143,823	\$199,754	\$55,931	72%	\$61,936,258	72%	\$86,022,581
326199A141	Rotor Blade	Other fabricated fiberglass and reinforced products	\$1,228,856	\$1,706,744	\$477,888	72%	\$61,936,258	72%	\$86,022,581
3315111116	Blade Extender	Ductile iron fittings 14 in. or more	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
3315111116	Tower Flange and Bolts	Ductile iron fittings 14 in. or more	\$116,412	\$141,966	\$25,554	82%	\$11,875,995	82%	\$14,482,921
3315113221	Hub	Other ductile iron casting for all other uses	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
3315113221	Nacelle Frame	Other ductile iron casting for all other uses	\$1,132,928	\$1,381,620	\$248,692	82%	\$11,875,995	82%	\$14,482,921
3323125106	Towers	Fabricated structural iron and steel for transmission towers, radio antenna, and supporting structures	\$447,973	\$829,580	\$381,607	54%	\$13,969,307	54%	\$25,869,087
3329915025	Bearings	Other roller bearings, spherical roller bearings, including hourglass and □ barrel, double row	\$1,171,970	\$1,412,012	\$240,042	83%	\$5,934,983	83%	\$7,150,582
33341204	Cooling System	Axial fans	\$214,650	\$351,885	\$137,235	61%	\$2,011,616	61%	\$3,297,731
3336110871	Generator	Turbine generators	\$126,705	\$226,259	\$99,554	56%	\$6,594,972	56%	\$11,776,736
3336127438	Gear Box	Enclosed concentric and parallel (Planetary) center distance 6 in. or more	\$46,211	\$60,804	\$14,593	76%	\$2,434,918	76%	\$3,203,839
3336133111	Brakes	Friction-type Clutches and Brakes	\$239,988	\$315,774	\$75,786	76%	\$3,023,510	76%	\$3,978,303
3336133329	Coupling	Non-gear-type flexible couplings	\$183,987	\$242,088	\$58,101	76%	\$3,023,510	76%	\$3,978,303
3336133792	Shafts	equipment, NEC, except parts	\$550,527	\$724,378	\$173,851	76%	\$3,023,510	76%	\$3,978,303
334418A015	Electronic Controller	Industrial process control board assemblies	Not Available	Not Available	Not Available	Not Available	\$28,544,444	70%	\$40,777,777
3345197	Sensors/Data Loggers	Commercial, Meteorological, Geophysical, and General Purpose	\$771,926	\$1,087,219	\$315,294	71%	\$5,004,377	71%	\$7,048,418
3345197025	Anemometer	Other meteorological instruments	\$771,926	\$1,087,220	\$315,294	71%	\$5,004,377	71%	\$7,048,418
33531230	Pitch Drive	Integral horsepower motors and	\$1,123,119	\$1,581,858	\$458,739	71%	\$11,911,618	71%	\$16,776,927
33531230	Yaw Drive	Integral horsepower motors and	\$249,590	\$351,535	\$101,945	71%	\$11,911,618	71%	\$16,776,927
335993219	Power Electronics	Other rectifying(power conversion)	\$469,154	\$660,780	\$191,626	71%	\$6,760,387	71%	\$9,521,672

**Demand for Solar Components as % of Available Production Capacity: 23150 MW**

10 Digit NAICS Codes	10 Digit NAICS Code Description	NAICS Code Description	Current Industrial Output	Industrial Output at 100% Capacity Utilization	Available Production Capacity	% of Full Production Capacity for Specific 6 digit NAICS	Total Product Shipments Value (\$1000) for 6 digit NAICS Code	% of Full Production Capacity Utilization Rates	(\$1000) of Total Production at full capacity for 6 digit
3252111160	Encapsulant	Other thermoplastic resins and plastics materials	\$8,898,938	\$9,998,807	\$1,099,869	89%	\$45,599,173	89%	\$51,235,026
3261130453	Rear Layer	Other unlaminated plastics film and sheet	\$4,814,538	\$6,334,918	\$1,520,380	76%	\$14,558,364	76%	\$19,155,742
3272111041	Top surface	Flat glass, nonautomotive, other than pyrolytically coated, clear, less than 5.0 mm thick	\$676,291	\$727,195	\$50,904	93%	\$2,750,510	93%	\$2,957,538
3314224218	Wiring	Copper apparatus wire and cord and flexible cord sets (except wiring harnesses and fiber optic), made in plants that draw wire	\$323,995	\$381,171	\$57,176	85%	\$3,020,874	85%	\$3,553,969
332322G331	Frame	Other aluminum sheet metal work	\$217,145	\$334,069	\$116,924	65%	\$15,327,820	65%	\$23,581,262
3344137015	Blocking Diode	Semiconductor rectifiers - power diodes and assemblies	\$396,428	\$471,938	\$75,510	84%	\$63,658,697	84%	\$75,784,163
334413A005	Solar cells	Solar cells	\$6,731,520	\$8,013,714	\$1,282,194	84%	\$63,658,697	84%	\$75,784,163
334413A010	Complete Module	Photovoltaic modules	Not Available	Not Available	Not Available	84%	\$63,658,697	84%	\$75,784,163
3345151105	Meter	Integrating instruments, electrical, demand meters, kW and kVA, combined watt-hour	\$623,524	\$916,947	\$293,423	68%	\$9,773,796	68%	\$14,373,229
3353131100	Circuit Breakers and Fuses	Power circuit breakers, all voltages	\$696,789	\$1,039,984	\$343,195	67%	\$7,894,237	67%	\$11,782,443
3359315100	Switch Gear	Current-carrying switches for	\$1,830,269	\$2,691,572	\$861,303	68%	\$6,507,922	68%	\$9,570,474
3359317100	Electrical	Current-carrying metal contacts,	\$218,992	\$322,047	\$103,055	68%	\$6,507,922	68%	\$9,570,474
3359993104	Charge Controller	Semiconductor battery chargers, industrial and railroad	\$122,551	\$172,607	\$50,056	71%	\$7,276,200	71%	\$10,248,169
3359993219	Inverter	Other rectifying (power	\$419,404	\$590,710	\$171,306	71%	\$7,276,200	71%	\$10,248,169

**Demand for Biomass Components as % of Available Production Capacity: 21760 MW**

10 Digit NAICS Codes	10 Digit NAICS Code Description	NAICS Code Description	Current Industrial Output	Industrial Output at 100% Capacity Utilization	Available Production Capacity	% of Full Production Capacity for Specific 6 digit NAICS	Total Product Shipments Value (\$1000) for 6 digit NAICS Code	% of Full Production Capacity Utilization Rates	Market Value (\$1000) of Total Production at full capacity for 6 digit NAICS Code
3279934321	Equipment Insulation	Mineral wool for industrial, equipment, and appliance pipe insulation	\$165,624	\$194,852	\$29,228	85%	\$4,917,908	85%	\$5,785,774
3312100100	Piping	Iron and steel pipes and tubes, made from purchased iron and steel	\$7,107,813	\$10,935,097	\$3,827,284	65%	\$7,112,294	65%	\$10,941,991
3324101101	High Pressure Feedwater Heaters	Fabricated bar tube industrial heat exchangers, closed types (except nuclear applications)	\$467,411	\$865,576	\$398,165	54%	\$3,356,471	54%	\$6,215,687
3324101101	Deaerating Feedwater Heater	Fabricated bar tube industrial heat exchangers, closed types (except nuclear applications)	\$467,411	\$865,576	\$398,165	54%	\$3,356,471	54%	\$6,215,687
3324101101	Low Pressure Feedwater Heaters	Fabricated bar tube industrial heat exchangers, closed types (except nuclear applications)	\$467,411	\$865,576	\$398,165	54%	\$3,356,471	54%	\$6,215,687
3324101311	Condenser	Fabricated steam condensers (except nuclear applications)	\$219,258	\$406,033	\$186,775	54%	\$3,356,471	54%	\$6,215,687
3324105106	Auxiliary Boiler	Water tube steel power boilers (stationary and marine), more than 15 p.s.i. steam working pressure, 100,000 lb per hour or less, saturated (except nuclear applications)	\$11,167	\$20,680	\$9,513	54%	\$3,356,471	54%	\$6,215,687
3324105126	Boiler Equipment	Water tube steel power boilers (stationary and marine), more than 15 p.s.i. steam working pressure, 100,001 lb per hour or more, saturated (except nuclear applications)	\$40,146	\$74,344	\$34,198	54%	\$3,356,471	54%	\$6,215,687
332420C121	Oil Storage Tank	Other ferrous metal nonpressure storage tanks, complete at factory (including tanks for trailers, metal septic tanks, etc.)	\$681,471	\$1,174,950	\$493,479	58%	\$4,432,904	58%	\$7,642,938
332420C121	Boiler Feedwater Tank	Other ferrous metal nonpressure storage tanks, complete at factory (including tanks for trailers, metal septic tanks, etc.)	\$681,471	\$1,174,950	\$493,479	58%	\$4,432,904	58%	\$7,642,938
3331201479	Front End Loaders	Wheel loaders, rear engine mount, integral design, 4-wheel drive, non-skid steer, 150 to 249 NEHP	\$1,288,115	\$2,259,851	\$971,736	57%	\$16,588,722	57%	\$29,103,021
3332103126	Wood Handling	Other woodworking sawmill equipment	\$118,018	\$240,853	\$122,835	49%	\$863,355	49%	\$1,761,949
3334111110	Breeching and Precipitator	Dust collection and other air purification equipment for industrial gas cleaning systems (for cleaning outgoing air), except parts	\$594,311	\$1,007,307	\$412,996	59%	\$2,149,175	59%	\$3,642,669
3334120324	Forced Draft Fan	turboblowers, and multistage blowers	\$181,130	\$329,327	\$148,197	55%	\$1,669,747	55%	\$3,035,904
3334120324	Induced Draft Fan	turboblowers, and multistage blowers	\$181,130	\$329,327	\$148,197	55%	\$1,669,747	55%	\$3,035,904
333414A101	Oil Burning Equipment	Oil burners	\$157,344	\$266,685	\$109,341	59%	\$3,856,924	59%	\$6,537,159
3334159121	Cooling Tower	Evaporative air coolers	\$125,829	\$209,715	\$83,886	60%	\$23,279,000	60%	\$38,798,333
3336110101	Turbine Generator	Turbine generator sets	\$2,677,815	\$3,042,972	\$365,157	88%	\$13,775,117	88%	\$15,653,542
3339111440	Well Water Supply System	Industrial pumps, except hydraulic fluid power	\$2,784,997	\$4,156,712	\$1,371,715	67%	\$6,493,599	67%	\$9,691,939

**Demand for Biomass Components as % of Available Production Capacity: 21760 MW**

10 Digit NAICS Codes	10 Digit NAICS Code Description	NAICS Code Description	Current Industrial Output	Industrial Output at 100% Capacity Utilization	Available Production Capacity	% of Full Production Capacity for Specific 6 digit NAICS	Total Product Shipments Value (\$1000) for 6 digit NAICS Code	% of Full Production Capacity Utilization Rates	Market Value (\$1000) of Total Production at full capacity for 6 digit NAICS Code
333911146H	Boiler Feed Pumps	Centrifugal pumps, multistage, single or double suction, volute or diffuser design, axially split case, over 8 in. discharge	Not Available	Not Available	Not Available	67%	\$6,493,599	67%	\$9,691,939
333911146H	Other Water Pumps	Centrifugal pumps, multistage, single or double suction, volute or diffuser design, axially split case, over 8 in. discharge units	Not Available	Not Available	Not Available	67%	\$6,493,599	67%	\$9,691,939
3339121166	Air Compressors	Air compressors, new, stationary, centrifugal and axial	\$2,244,837	\$4,008,638	\$1,763,801	56%	\$4,180,989	56%	\$7,466,052
3339228101	Reclaim Conveyor	Bulk material handling belt conveyors and conveying systems, except hoists and farm elevators	\$554,934	\$1,008,971	\$454,037	55%	\$5,030,639	55%	\$9,146,616
3339228101	Boiler House Feed Conveyor	Bulk material handling belt conveyors and conveying systems, except hoists and farm elevators	\$554,934	\$1,008,971	\$454,037	55%	\$5,030,639	55%	\$9,146,616
3339228316	Ash Handling System	Bulk material handling pneumatic conveyors and conveying systems, except	\$97,775	\$177,773	\$79,998	55%	\$5,030,639	55%	\$9,146,616
3339233116	Turbine Overhead Crane	Gantry type overhead traveling cranes (except construction power cranes)	\$24,454	\$49,906	\$25,452	49%	\$2,819,455	49%	\$5,753,990
3339951100	Dumper Hydraulic Unit	Nonaerospace type hydraulic fluid power cylinders and actuators, linear and rotary	\$956,722	Not Available	Not Available	62%	\$3,080,254	62%	\$4,968,152
3339971101	Truck Scale	Motor truck scales	\$64,482	\$128,964	\$64,482	50%	\$633,275	50%	\$1,266,550
3339991104	Water Purification	Filter and strainer assemblies (containment or housing devices), with or without filter element installed, for water; except parts and accessories (except for fluid power systems)	\$990,886	\$1,801,611	\$810,725	55%	\$8,792,278	55%	\$15,985,960
3345130100	Instrumentation	Process control instruments	\$6,268,416	\$10,807,614	\$4,539,198	58%	\$6,965,328	58%	\$12,009,186
3353117111	Main Transformer	Commercial, institutional, and industrial general-purpose transformers, single- and three-phase, 100.01 kVA and above, all voltages	\$17,265	\$27,405	\$10,140	63%	\$4,656,788	63%	\$7,391,727
335313A101	Switchgear	Switchgear (except ducts), automatic and manual control panels (generators, transformers, feed-controls, etc.)	\$2,261,724	\$3,533,944	\$1,272,220	64%	\$7,398,285	64%	\$11,559,820
3365103100	Woodchip Railcars	Freight train and passenger train cars, new (excluding parts)	\$1,269,139	\$2,820,309	\$1,551,170	45%	\$6,319,201	45%	\$14,042,669

**Demand for Geothermal Components as % of Available Production Capacity: 15190 MW**

10 Digit NAICS Codes	10 Digit NAICS Code Description	NAICS Code Description	Current Industrial Output	Industrial Output at 100% Capacity Utilization	Available Production Capacity	% of Full Production Capacity for Specific 6 digit NAICS	Total Product Shipments Value (\$1000) for 6 digit NAICS Code	% of Full Production Capacity Utilization Rates	Market Value (\$1000) of Total Production at full capacity for 6 digit NAICS Code
33121001H0	Piping	Alloy steel pipe and tubes, miscellaneous (including standard and structural)	\$7,107,813	\$7,986,307	\$878,494	89%	\$6,608,720	89%	\$7,425,528
33121001H0	Well casing	Alloy steel pipe and tubes, miscellaneous (including standard and structural)	\$7,107,813	Not Available	Not Available	89%	\$6,608,720	89%	\$7,425,528
3324101206	Evaporator	Fabricated fin tube industrial heat exchangers, closed types (except nuclear applications)	\$566,954	\$609,628	\$42,674	93%	\$3,644,867	93%	\$3,919,212
3324101311	Condenser	Fabricated steam condensers (except nuclear applications)	\$219,258	\$257,951	\$38,693	85%	\$3,644,867	85%	\$4,288,079
3324209111	Accumulator	Other pressure tanks (including anhydrous ammonia tanks), ferrous and nonferrous metal, complete at factory (standard line pressure)	\$238,275	\$366,577	\$128,302	65%	\$4,771,488	65%	\$7,340,751
332420E106	Steam cyclone separator	and vessels (more than 24 inch outside diameter and not less than 5 cu ft capacity), custom fabricated at the factory, for	\$243,554	\$289,945	\$46,391	84%	\$4,771,488	84%	\$5,680,343
332420E106	Flash vessel	and vessels (more than 24 inch outside diameter and not less than 5 cu ft capacity), custom fabricated at the factory, for	\$243,554	\$289,945	\$46,391	84%	\$4,771,488	84%	\$5,680,343
3331325101	Wellhead valves and controls	Oil and gas field production well Christmas tree assemblies (excluding subsea)	\$110,884	\$132,005	\$21,121	84%	\$5,467,847	84%	\$6,509,342
3331325101	Silencer	Oil and gas field production well Christmas tree assemblies (excluding subsea)	\$110,884	\$132,005	\$21,121	84%	\$5,467,847	84%	\$6,509,342
3334120573	Air-cooled Condenser	connected to driver	\$33,454	\$49,197	\$15,743	68%	\$1,832,169	68%	\$2,694,366
3334159121	Evaporative Cooling Tower	Evaporative air coolers	\$125,829	\$187,804	\$61,975	67%	\$24,165,747	67%	\$36,068,279
3336110101	Turbine Generator Set	Turbine generator sets	\$2,677,815	\$3,937,963	\$1,260,148	68%	\$15,017,885	68%	\$22,085,125
3339111484	Downhole Pump	Centrifugal pumps, propeller and	\$2,784,997	\$4,095,584	\$1,310,587	68%	\$7,071,482	68%	\$10,399,238
3339111484	Working Fluid Pump	Centrifugal pumps, propeller and	\$2,784,997	\$4,095,584	\$1,310,587	68%	\$7,071,482	68%	\$10,399,238
333911148M	Condensate Pump	All other centrifugal pumps, over	\$2,784,997	\$4,095,584	\$1,310,587	68%	\$7,071,482	68%	\$10,399,238
333911148M	Cooling water pumps	All other centrifugal pumps, over	\$2,784,997	\$4,095,584	\$1,310,587	68%	\$7,071,482	68%	\$10,399,238
333911148M	Brine injection pump	All other centrifugal pumps, over	\$2,784,997	\$4,095,584	\$1,310,587	68%	\$7,071,482	68%	\$10,399,238
333911148M	Fire Water Pump	All other centrifugal pumps, over	\$2,784,997	\$4,095,584	\$1,310,587	68%	\$7,071,482	68%	\$10,399,238
3339121220	Steam-jet Ejectors	Vacuum pumps (compressors) (including value of the driver if shipped as a complete unit), except laboratory	\$316,055	\$445,148	\$129,093	71%	\$4,819,505	71%	\$6,788,035
3339121277	Vacuum Pump	Vacuum pumps (excluding laboratory), high vacuum, 29.6 in. mercury vacuum and over, 5 hp and over	Not Available	Not Available	Not Available	71%	\$4,819,505	71%	\$6,788,035
3339233116	Gantry Crane	cranes (except construction power cranes)	\$24,454	\$34,442	\$9,988	71%	\$2,870,168	71%	\$4,042,490