California Institute for the Study of Specialty Crops

Final Report

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Project Title:

California Renewable Energy Overview for Agriculture

Submitted by Project Director

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Executive Summary

The purpose of this study is to document the current and projected demand for renewable electricity and renewable fuels in California, and to estimate the current and future contribution of renewable energy sourced from California agriculture. An overview of current relevant state and federal policies that encourage renewable energy production and consumption is provided. A summary of the findings are as follows:

Renewable Electricity

Solar Power: Most of the 28 million acres devoted to California agriculture are in areas with good-to-excellent solar power potential, based on solar resource maps. Despite the fact that the Go Solar Initiative (GSI) can fund up to half the cost of a solar installation, and net metering provisions can greatly reduce electricity costs for farms and agribusinesses in the long run, it seems that very few agricultural businesses are taking advantage of these programs. A conservative estimate for solar installations scaled appropriately to farm size indicates that over 1,300 MW could be gained toward the GSI's 3,000 MW installation goal by 2017. Currently, solar energy provides barely 400 MW of the state's energy resources, or less than .05%. The estimates from this study indicate that an addition 5% of the state's electricity needs could come from agriculturally based solar power.

Wind: Wind energy currently contributes about 2% of California's electricity. Wind energy is much more geographically specific than is solar energy, so it may have more limited applications in California agriculture. Even so, there are many opportunities for California farms in the wind resource areas to take advantage of generous rebate programs and net metering for small wind systems. The rebates are similar to those in solar, and can offset half of the cost of a wind system. Because the current policy scenario does not favor farmer-owned, commercial-scale wind systems (as is possible in other states), small wind systems to save long-term energy costs and to reduce demand on the grid are the best option for California agribusinesses.

Agricultural Waste Biomass: Current agricultural biomass contributes 173.6 MW of online energy capacity to California, which is 0.18% of the total MW capacity of all power plants in California. The net technical potential for agricultural waste biomass is 880 MW. That 880 MW would produce an additional 6,554 GWh in electrical energy or 2% of the 283,000 GWh of electricity currently used in California, which is double the current amount of biomass electricity generated from all sources in California. Agricultural waste biomass can play an important role in meeting the state goals for biomass energy use. Programs such as the Dairy Power Production Program and net metering for biogas encourage development of biomass plants; however, net metering is limited to 50 MW for biogas generation, which appears to be low, given the potential of 880 MW from biogas in the state.

Renewable Fuels:

Ethanol: California is the nation's largest consumer of ethanol at 951 million gallons, but produces just over 10 percent of its current ethanol needs. State renewable fuel production goals and the federal Renewable Fuels Standards may double the ethanol needed in the state by 2020, depending on fuel blend percentages, to approximately 2 billion gallons. In-state ethanol is produced primarily from imported Midwest corn. It is unlikely that California will meet its ethanol production needs from corn and starch crops grown in the state; even if every acre of land currently committed to those crops was used for ethanol production, it would produce less than half of the current ethanol demand. Moving additional crop acres into these crops is unlikely, as the competition for land resources in this high-value, specialty crop state is already intense. Cellulosic ethanol, should it ever become commercially viable, may provide a solution to meeting in-state ethanol production goals. An estimate that included both agricultural biomass wastes as well as 1.3 million acres of a dedicated cellulosic ethanol crop showed a range of ethanol production potential of 884 to 1,635 million gallons. Federal research goals call for developing a commercially viable cellulosic technology by 2015.

Biodiesel: In order to meet the state production goals for biodiesel at the lowest blend rate of 2%, the number of acres committed to oilcrops would need to more than double by 2010, from 56,000 grown in 2006 to more than 130,000. Soybeans, the predominant feedstock for biodiesel in the U.S., are not suitable for California's climate. Safflower is grown in the state and could be used for biodiesel production, and research is being conducted on canola. If in-state production goals are to be met at the highest blend rate (100% biodiesel) by 2050, the acreage requirements are equal to half of the current agricultural acreage in California, or about 14 million acres.

In summary, it seems more feasible for California to increase its development of agricultural sources of electricity in the near future than it will be to move into large-scale biofuels production. Proven technology and generous policies are already in place for California farms, ranches and agribusinesses to take advantage of solar, wind and biomass electricity resources. There are literally millions of dollars available each year in rebate and grant programs to implement solar, wind and biomass projects that the California agricultural industry leaves on the table. Most of these projects would be considered distributed energy projects, and would decrease energy costs over the long term, reduce demand on the electric grid, and reduce California's reliance on imported electricity. Producing electricity from renewable sources on farms, ranches and agribusinesses is a complementary, not competitive, activity.

Though biofuels seem to have captured the attention of policymakers and the public at large to a much greater extent than renewable electricity, the opportunity costs are quite high for California to develop its own base of biofuels using current production technology. Steep competition for the considerable land and water resources needed for ethanol production and the enormous impact on dairy and other livestock sectors as feedstocks are converted to fuel cannot be ignored. Biodiesel has the same issues, but to a lesser extent. Cellulosic ethanol, which is not currently commercially available, may hold some promise without the food/feed issues associated with starch-based ethanol. However, land and water resources will still be needed, and competition for those resources will remain, and infrastructure needed to support cellulosic ethanol products is as yet unknown.

Acknowledgements

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Chapter 1 – Introduction to Renewable Energy in California

California has the most diverse supply of renewable energy in the nation, and is the birthplace of many renewable energy initiatives. The first commercial wind farms were developed in the mountain passes of California in the 1980s, and until 2006, California led the nation in wind energy generation. Solar power has also taken hold in the sunshine state, which is currently home to some of the world's largest solar installations in the Mojave Desert. Small hydroelectric plants and geothermal systems contribute nearly 7 percent of the state's electricity needs. Millions of tons of dairy manure and orchard trimmings are being converted to energy for the state's growing population. New biodiesel and ethanol plants are under construction to meet the increasing demand for renewable transportation fuels.

Though the state had a strong head start in renewable energy, the new energy economy and growing concern for greenhouse gas emissions has caused the California to pause and consider its options for increasing the homegrown supply of energy. States such as Minnesota and Iowa are surging ahead in farmer-owned wind energy while ethanol and biodiesel plants are dotting the rural landscape in the heartland. Solar energy, perhaps the source of energy in which California has the greatest competitive advantage, is growing rapidly with the state's urban constituency – but has barely made a dent in the vast California countryside. This is despite the fact that California growers qualify for millions of dollars of federal and state cost-share incentives and, in some cases, tax credits for installing renewable energy systems.

This study divides renewable energy from agriculture into two primary areas - those resources that provide electricity and those that are used for renewable transportation fuels. Renewable sources of electricity that will be presented are wind, solar and biomass. Transportation fuels sections will focus on ethanol and biodiesel. California also employs a variety of other renewable energy sources, such as hydroelectric, fuel cells and geothermal, but the applications and opportunities for those technologies are very limited in agriculture at this time. Separate sections for each of the specific types of renewable energy will document the current available supply of these energy sources, the current and projected demand, as well as the potential for supplying increased levels of these renewable sources from agriculture. Some of these renewable energy sources have policies that specifically address that technology or resource, and such incentives will be presented in the relevant section.

The report is essentially a review and compilation of a number of existing reports, as the State of California has invested significant resources toward documenting, forecasting and making available to the public information about the state's energy resources. The primary contribution of this report is that it estimates the portion of renewable energy resources that could be developed from agriculture so that the industry can have a better understanding of the opportunities and challenges ahead as the renewable era expands.

Current Energy Status

California has a very diverse energy portfolio, and produces a large portion of its energy within the state. Recent legislation and executive orders have set goals for increasing the level of renewable energy produced in-state. The intention is to reduce dependence on foreign energy sources, increase economic development opportunities in the state, and improve environmental quality. The current sources of California's energy supplies are shown on Table 1.1.

Table 1.1. California Energy Supply

Petroleum (2005)	**Gasoline (2006)**	**Electricity (2006)**	**Natural Gas (2005)**
Source	**Source**	**Source**	**Source**
In-State 37.22%	**In-State 90%**	**In-State 78.03%**	**In-State 15.0%**
Alaska 20.99%	Rest of US 10%	Natural Gas 41.5%	Canada 23.0%
Foreign 41.79%		Nuclear 12.9%	Rockies 24.0%
		Large Hydro 19.0%	Southwest 38.0%
		Coal* 15.7%	
		Renewable 10.9%	
		Other States 21.97%	
		Pacific Northwest 6.72%	
		Desert Southwest 15.25%	

* Intermountain and Mojave coal plants, although outside of California are considered in-state since they are in California utilities' control areas.
Source: California Energy Commission

A review of Table 1.1 shows California is dependent on foreign sources for 41% of its petroleum which is used primarily in gasoline and electrical energy production, and 23% of its natural gas which is also used in part to produce electricity. Most of California's electricity is produced in-state, but heavy reliance on natural gas keeps electric prices high. Similar concerns abound with the 42% of petroleum that is imported. Increasing the harvest of renewable energy sources from California's vast agricultural base has gained traction as the prices of fossil fuels rise, as well as increasing concerns about their contributions to greenhouse gas emissions.

Chapter 2 - Renewable Electricity from Agriculture: Overview

California is very diverse in its range of electricity sources but coal, large hydroelectric, natural gas and nuclear power comprise nearly 90% of the power, as reported in Table 2.1.

Table 2.1 California Gross System Power for 2006 in Gigawatt-Hours (GWh)

Fuel Type	In-State	NW Imports	SW Imports	GSP	GSP Percentage
Coal {2}	17,573	5,467	23,195	**46,235**	**15.7%**
Large Hydro	43,088	10,608	2,343	**56,039**	**19.0%**
Natural Gas	106,968	2,051	13,207	**122,226**	**41.5%**
Nuclear	31,959	556	5,635	**38,150**	**12.9%**
Renewables	30,514	1,122	579	**32,215**	**10.9%**
Biomass	5,735	430	120	6,285	2.1%
Geothermal	13,448	0	260	13,708	4.7%
Small Hydro	5,788	448	0	6,236	2.1%
Solar {1}	616			616	0.2%
Wind	4,927	244	199	5,370	1.8%
TOTAL	230,102	19,804	44,959	**294,865**	**100.0%**

Source: *2006 Net System Power Report*, Energy Commission Publication # CEC-300-2007-007. (date on line April 12, 2007). Available at www.energy.ca.gov

Notes:

1. This number only includes generator-reported electricity, not electricity produced by many small-scale photovoltaic installations throughout the state. Based on the Energy Commission's Renewable Energy Program records, the state has financed approximately 135,517 kilowatts (kW) of solar photovoltaic capacity. Assuming that each installed kW of PV-generated 1,500 kWh in 2005, then the combined output of these PV systems would add another 203.3 gigawatt-hours to the gross system power totals.
2. The in-state coal-fired generation includes electricity generated from several out-of-state coal-fired power plants that are owned by and reported by California utilities. There are other out-of-state generation facilities that are owned by California utilities, which are reported as imports.

This report will be concerned with agricultural sources of wind, biomass and solar electricity generation. The total contribution from each technology to the state's energy supply hovers around 2 percent. However, a number of policies have been enacted to encourage both the production and purchase of renewable energy, most of them directed at least partially, if not wholly, toward agricultural sources.

Renewable sources of electricity have the benefit of being very scalable. A grower could decide to place solar panels on the roof of a building, or to install a small wind turbine, and benefit from reducing electricity purchases from the utility. Referred to as "distributed generation," small wind and solar projects can reduce reliance on outside energy sources, ease demand on the electric grid, well as provide energy cost savings over time. Biomass projects can also be designed as distributed generation projects, depending on the size and technology of the operation. For example, some of the smaller dairy waste biomass projects supply energy to the dairy operation, rather than selling electricity to a utility. Because smaller solar, wind and biomass projects are built to self-supply electricity, and not to generate it for sale to a utility, different policies are in place to encourage the adoption of these technologies, as they typically have high upfront costs that create barriers for adoption.

Solar, wind and biomass systems can also be built as commercial-scale projects; these are the projects that typically attract more attention from the public and policy makers. These are built with the primary goal of supplying renewable energy to a utility, and sometimes are owned by utilities themselves. Policies to support utility-scale renewable development typically influence the demand for and financing of these projects by providing mandates to utilities to purchase a certain amount of renewable energy, or by providing tax credits or other mechanisms to improve the financial outcomes of the project. Table 2.2 provides an overview of the policies that support renewable electricity by scale. The last two policies are applicable to both small and commercial-scale projects.

Table 2.2 Overview of policies supporting renewable energy development by scale

Size of Renewable Electricity Project Targeted	
Smaller Scale	**Commercial Scale**
Emerging Renewables Program (S)	Renewable Portfolio Standard (S)
Self-Generation Incentive Program (S)	Production Tax Credit (F)
Net Metering or Co-Metering (S)	
Public Interest Energy Research (S)	
Renewable Resources Trust Fund (S)	
2002 Farm Security and Rural Investment Act, Section 9006 (F)	

(S) – State, (F) – Federal

State Policies for Renewable Electricity[1]

Smaller-Scale Electric Systems

The Renewable Resources Trust Fund.
This is a Public Benefits Fund initially established in the amount of $540 million by AB 1890 (1996) and extended through 2012 by AB 995 (2000) with an additional $1.35 billion. The trust fund manages four accounts including the Existing Renewable Facilities Program, the New Renewables Program, the Emerging Renewables Program, and the Consumer Education Program, all administered by the California Energy Commission. More information on the specific incentive programs follow.

Emerging Renewables Program
The California Energy Commission administers this cash rebate program, available for grid-connected small wind energy electric-generating systems and fuel cells. Small wind turbines with a rated output of 50 kW or less are eligible as of January 1, 2007. The rebate is $2.50 per watt for the first 7.5 kW of the system, and $1.50 per watt for the increments of watts greater than 7.5 kW, but less than 30 kW. The electricity generated can be up to 100 percent of the customer's usage, and the turbine system must have a five-year warranty for the maximum rebate eligibility. Residential, commercial, school and agricultural customers are all eligible for this rebate. This program is funded at $56.2 million per year.

Self-Generation Incentives Program
The California Public Utilities Commission administers this program through the state's investor-owned utilities. It funds rebates for wind systems sized up to 5 MW, and differs from the Emerging Renewables Program in that it is designed to encourage larger scale projects used by a business. The incentives vary by fuel type (it also funds fuel cells), but for wind turbines, the incentive is $1.50 per watt, for turbines between 30 kW and 5 MW. The incentive reaches a maximum at 1 MW, which equates to $1.5 million per project. Nearly $75 million in funding was available for this program in 2007.

Net Metering
California has had a net metering law since 1996, which requires utilities to allow customers to net meter solar photovoltaic, landfill gas, wind, fuel cells, and anaerobic digestion systems. For those customers who generate their own power via these technologies, their electric meter turns backward during the times they are producing energy, and the consumer is given a credit for any energy produced in excess their use. Essentially, the utility acts as a bank for any excess generation for a 12-month period. If any credits remain in the customer's account, the utility is not required to pay the customer for the excess energy generated; the value of that energy is returned to the

[1] More detailed information about all of these incentive programs can be found at the Database of State Incentives for Renewable Energy, www.dsire.org (updated Sept. 12, 2007) and the California Energy Commission, www.energy.ca.gov

utility. The law was amended in September 2002 (AB 2228) to permit wind energy projects up to 50 kW to net meter, and require wind projects from 50 kW to 1 MW to utilize "wind energy co-metering" which values the energy used or credited at the time in which it was either produced or used. Up to three biogas digesters can be net metered for up to 10 MW, but there is a statewide limit of 50 MW for net metering biogas digesters. Projects that are net metered are exempt from "exit fees" or "departing load fees" which would substantially reduce the value of the policy.

The Public Interest Energy Research (PIER) Program
This program was established by AB 1890 (1996). The California Energy Commission administers the Energy Innovations Small Grant (EISG) Program which provides up to $75,000 to small businesses, non-profits, individuals, and academic institutions to conduct research that establishes the feasibility of new, innovative energy concepts. Qualifying renewable energy sources include solar radiation, geothermal fluids, biomass, water, and wind. Technology applications include, but are not limited to: photovoltaic systems; solar thermal; wind turbines; hydropower; geothermal energy; and biomass energy. About $2.4 million are available annually.

Federal Policies to Support Smaller-scale Renewable Electricity

The Farm Security and Rural Investment Act of 2002, Section 9006
This was the first farm bill to include energy provisions, and it established a number of programs for energy and bio-based products. The primary initiative is the Renewable Energy Systems and Energy Efficiency Improvements Program under the Rural Development Office of the USDA, also known as Section 9006. This program authorizes loans, loan guarantees, and grants to farmers, ranchers, and rural small businesses to purchase renewable energy systems and make energy efficiency improvements. Grant awards can range from $2,500 to $500,000. The program has awarded between $11 and $23 million annually since 2003. The Value-Added Producer Grant program funds matching grant awards for planning activities and working capital associated with marketing agricultural products and farm-based renewable energy. To qualify for these programs, the applicant must own and operate a farm or a small business in a rural area.

Through 2007, only 10 California projects have received these awards. Since 2003, California agribusinesses have received just over $1.7 million dollars to help fund four solar projects and six dairy anaerobic digesters. This is out of a total award pool of nearly $100 million. By comparison, Minnesota farms and businesses have garnered over $20 million over the past five award cycles, and Iowa farms have earned over $10 million. The majority the funds to those two states have gone toward farmer-owned, commercial-scale wind projects.[2]

[2] USDA Rural Development, 9006 Program recipients, various years. Available at www.rurdev.usda.gov

Policies to Support Commercial-Scale Renewable Electricity

State Level

Renewable Portfolio Standard (RPS)

While net metering encourages smaller renewable energy systems for residential or businesses, the Renewable Portfolio Standard (RPS) encourages larger scale installations of renewable energy. California has had an RPS since 2002. The law was amended in 2003 and 2006, and utilities or other retail sellers of electricity must increase their sales of renewable energy by at least 1 percent of retail sales per year. By 2010, 20 percent of utilities' retail sales must originate from renewable energy sources. Eligible technologies are solar thermal electric, photovoltaic, landfill gas, wind, biomass, geothermal electric, municipal solid waste, anaerobic digestion, small hydroelectric and tidal energy. Governor Schwarzenegger has set a longer-term state goal of 33% by 2020, and currently the California Public Utilities Commission (CPUC) and the California Energy Commission are considering ways to achieve that goal. As of 2006, California supplies 11% of its electricity from renewable sources, the largest portion of which is hydroelectric.

The Renewable Resources Trust Fund.

One of the four accounts managed by this fund supports commercial-scale renewable energy; the Existing Renewable Facilities Program. It is funded at $15 million per year to support existing wind, solid-fuel biomass facilities and solar thermal electric facilities, however, most of the funding goes to the latter two technologies

Federal Policies to Support Renewable Electricity

Renewable Electricity Production Tax Credit

One of the most important public policies for the development of utility-scale renewable energy across the United States has been the production tax credit. It was enacted as part of the Energy Policy Act of 1992, and first expired in 2001. The tax credit has undergone a number of extensions since 2002, and the most current legislation, the Energy Policy Act of 2005 extended the tax credit through the end of 2007. In December 2006, the credit was extended for yet another year, to December 31, 2008, under Section 207 of the Tax Relief and Health Care Act of 2006 (H.R. 6111).

The tax credit is allocated per kilowatt-hour of energy produced from landfill gas, wind, biomass, hydroelectric, geothermal electric, municipal solid waste, refined coal, Indian coal and small hydroelectric. The tax credit is $.019/kWh for wind, geothermal and closed-loop biomass; and $.01/kWh for all other renewables listed. The credit applies during the first 10 years of operation. Only corporate entities are eligible for the tax credit, so this incentive primarily drives the development of commercial-scale renewable energy plants. Some farmer-owned renewable energy LLCs have been able to benefit indirectly from this policy, as it attracts equity investors that have large tax appetites.

The Farm Security and Rural Investment Act of 2002, Section 9006

Details of this program were discussed in the previous section. For commercial-scale wind and anaerobic digesters, Section 9006 grants of up to $500,000 are available to eligible applicants to offset 25% of the costs of implementing a large renewable energy project. The Value-Added Producer Grant will also provide matching funds to conduct feasibility studies and business plans for large renewable energy projects.

Chapter 3 - Solar Power

California's sunshine is one of the state's best known resources, but it is one of the most underutilized sources of renewable energy power in the state. Figure 3.1 shows that the overall technical potential for annual solar photovoltaic (PV) generation is 17 million MW statewide, or 16% of 2006 electricity use. However, the currently installed solar energy is 616 GWh, or .26% of 2006 electricity usage. This number only includes installed solar power plants; based on the Energy Commission's Renewable Energy Program records, the state has financed approximately 135,517 kilowatts (kW) of solar photovoltaic (PV) capacity in home and business solar energy systems. This would add another 203.3 gigawatt-hours to the gross system power totals. The total power generated by solar in the state would be approximately .35% of the total electricity used in the state.[3] Most of these systems are installed in residential and business applications. Commercial-scale solar thermal installations are being built in the Mojave Desert, and show great promise for increasing the level of solar power generated in the state.

The technical PV potential shown in Figure 3.1 has filtered out the areas in which solar systems would not be practical, for example, in state or national parklands, forested areas, or sensitive habitats, among others. The southeastern part of the state is home to the highest level of solar potential, with smaller regions in coastal inland valleys. However, much of the state has good solar potential, sufficient to power homes and businesses.

To encourage more residents and businesses to tap into this resource, California has launched the most aggressive solar adoption policy in the U.S. In 2006, Go Solar California made its debut, as part of Governor Arnold Schwarzenegger's $3.3 billon, Million Solar Roofs Program. The state's goal is to create 3,000 megawatts of new, solar-produced electricity by 2017 through providing incentives of up to 50% of the cost of a system. Agriculture is included in the incentives. More details of the program are discussed later in this chapter.

Solar cells, also referred to as photovoltaic or PV, are made of semiconductor materials similar to those found in computer chips. When these materials absorb sunlight, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. The process of converting light to electricity is called the photovoltaic effect. PV systems are quiet, have no emissions, no moving parts, and take no water or fuels to operate.[4]

PV systems are typically made up of "flat panel" collectors that can be consolidated into modules that are grouped into an array, all mounted on rigid, flat surface. Systems can be

[3] California Energy Commission, *California Gross System Electrical Production.* (cited 2007). Available at: http://www.energy.ca.gov/electricity/gross_system_power.html

[4] More information about various types of solar technologies is available from the California Energy Commission *California Solar Resources,* April 2005, CEC-500-2005-072D.

Figure 3.1 Technical PV Potential

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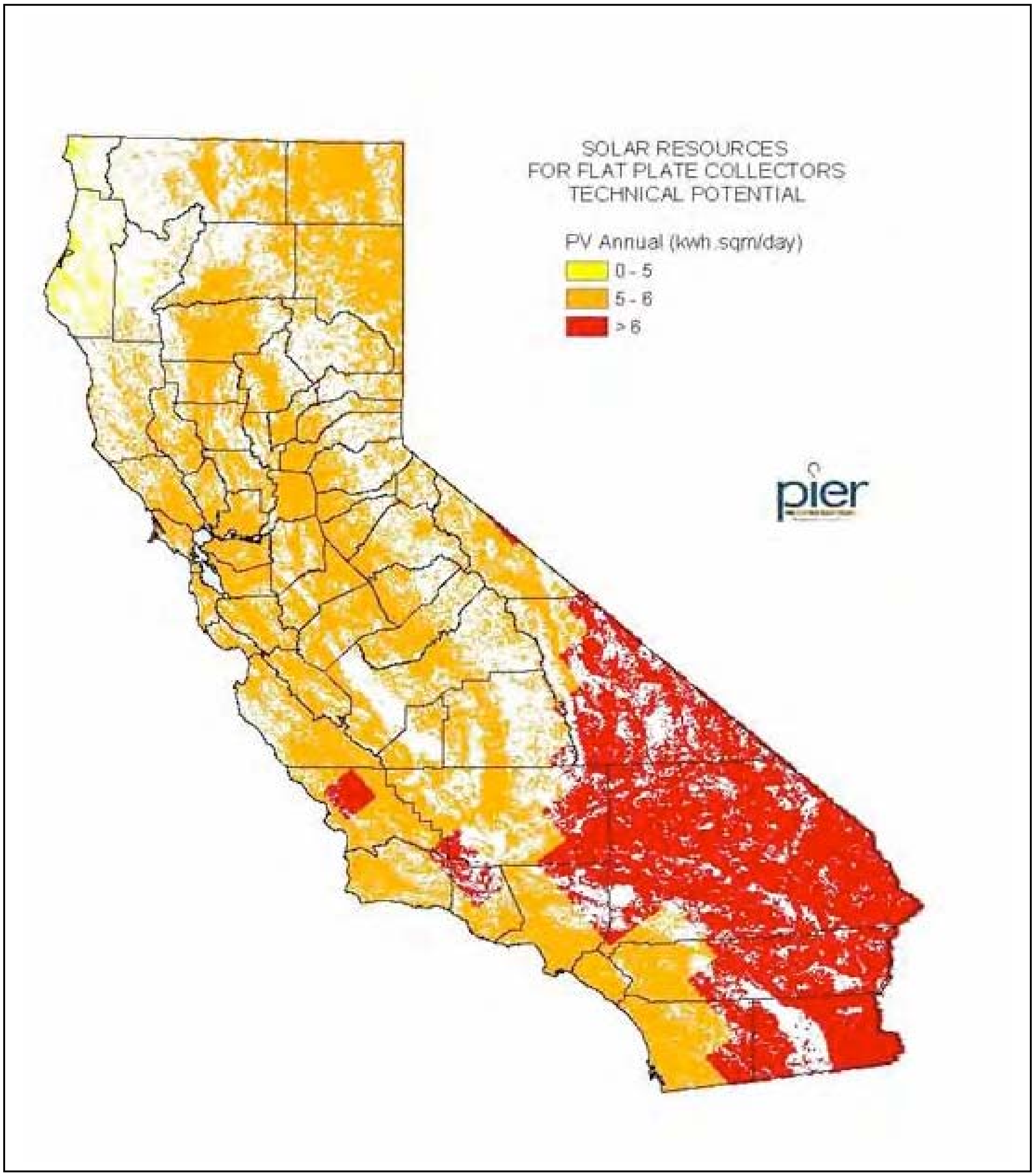

Source: California Energy Commission. *California Solar Resources*, April 2005 Commission report CEC-500-2005-072-D.

built as dedicated central station power plants, or as distributed generation systems on the roof of a home or business. One advantage of solar energy over other renewable electricity sources is that is very scalable – it is quite common to see small solar panels of just a few watts along roadsides, generating electricity for road signs, lights and call boxes. For agricultural applications, solar installations can be sized large enough to power a winery or fruit packing plant or small enough to energize remote electric fences or water pumps for off-grid applications.

Solar power is more expensive than other forms of renewable electricity, such as wind energy. Currently the U.S. Department of Energy estimates the cost of electricity produced from solar power to be in $0.18-$0.23 per kWh, which is about double the retail cost of other forms of electricity production across the U.S. A federal program, the Advanced Solar Initiative, announced as part of President Bush's Advanced Energy Initiative, awarded $168 million in cost-sharing grants to industry to encourage innovation to reduce the cost of solar electricity to the $.08 - $0.15 per kWh.

Solar PV potential in California agriculture

According to Figure 3.1, much of California's Central Valley and the southern part of the state have high potential for solar power, ranging from 5 to 7.5 kilowatt-hours (kWh) per square meter per day. For example, a building with a roof that could hold 500 sq. ft. of solar panels could generate over 100,000 kWh of energy in one year. To put that in perspective, a household typically uses around 10,000 kWh of electricity per year.[5]

Though the technologies are evolving, the most common installation is an array of flat panel solar collectors placed on flat or gently sloping western or southern exposed land or a roof. Large installations typically need a large surface area. For example, one megawatt of solar panels installed on land can take eight acres or more; while a one-megawatt wind turbine would need only one acre of land. However, in some areas, such as the Imperial Valley where farmers have fallowed land in order to sell or lease their water rights, solar panels can serve as a means of increasing income on land that is no longer in agricultural production. In addition, rooftop installations can work very well for agricultural businesses, as several California wineries and farms have shown.

It appears that many California farms and agribusinesses are in good or excellent regions to tap into solar energy. There are currently 76,000 farms and ranches in the state.[6] In order to estimate the potential solar energy available from California farms and ranches, USDA data is used to estimate the average size of farms in each sales category. Nearly half of the farms are classified in the smallest category of less than $10,000 in sales. These figures are shown in Table 3.1. Farms of this size are assumed to have similar

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[5] Energy Information Administration, Electricity Consumption by End Use in U.S. Households 2001. http://www.eia.doe.gov/emeu/reps/enduse/er01_us_tab1.html

[6] National Agriculture Statistics Service, USDA (2006), Available at http://www.nass.usda.gov/QuickStats

solar energy needs as that of a residential installation, which is 2.5 kW on average.[7] In estimating the PV system size per farm for the remaining categories, they are scaled up nearly the percentage increase of acreage and presumed increase in electricity use for buildings and operations. Also, 100 kW is the largest system size eligible for the Go Solar Initiative Expected Performance Based Buy-down, which is currently $2.50 per watt.

The largest farm size category of over $500,000 in sales shows a 10-fold increase in the estimated size of solar installation, for several reasons. First, USDA statistics show that farms in this category produce 85% of the annual value of California's approximately $35 billion annual agricultural sales. Many of these farms are multi-million dollar enterprises that have enormous electricity bills. Several agribusinesses in this sales category have installed systems of approximately 1 MW since 2005: P-R Farms in Clovis installed a 1.1 MW system on the roof of their 98,000-sq. ft. fruit packing facility;[8] and Paramount Farms installed a 1.1 MW solar system at their orchard and nut processing facility in Lost Hills.[9] Fetzer Vineyards of Hopland installed a 900 kW system on the roofs of its bottling facility and Red Wine Barrel Rooms.[10] These projects qualified for the state's incentive program for solar installations of over 100 kW, which could offset up to 50% of the cost. Though a 1 MW system can cost between $7 - $9 million dollars, and requires either large rooftop space, or up to 10 acres of land, depending on the technology, these large farms are able to save on electricity bills for the next 30 years or more (The businesses mentioned above estimated electricity savings of 50% for P-R Farms, 15% for Paramount and 80% for Fetzer).

To estimate the potential energy available from the solar PV systems, the Renewable Energy Atlas of West filters out 30% of agricultural lands as potentially impractical for solar. This analysis assumes one solar PV system per farm, and thus is more conservative than overall solar energy potential estimations using the land mass. In addition, PV systems have a range of efficiency, depending on technology; from 6-35%. An average efficiency rating of 20% was chosen for the calculations. The results are reported in Table 3.1

[7] California Energy Commission *California Solar Resources*, April 2005, CEC-500-2005-072D

[8] Lee, C. "California farmer plugs into solar in a big, big way." *California Country Magazine*, California Farm Bureau Federation. September/October 2005. Available at: http://www.cfbf.com/magazine

[9] Rueters. "California nut growers use sun for power, too." May 22, 2007. Available at: http://www.reuters.com/article/environmentNews/idUSN2240797420070522?pageNumber=1

[10] Parker, S. "Powered by Solar, Financed by Third-Party." Renewable Energy Access.com . January 4, 2007. Available at: http://www.renewableenergyaccess.com/rea/news/story?id=47009

Table 3.1 Estimate of Solar PV potential by farm size, 2006

Value of Sales (2006)	$1,000-9,999	$10,000-99,999	$100,000-249,999	$250,000-499,999	$500,000 +
Number of farms	30,200	25,700	7,500	4200	8400
Avg. farm size (acres)	56.3	218	520	810	1393
PV system size per farm	2.5 kW	10 kW	50 kW	100 kW	1 MW
Total	10.6 MW	36 MW	52.5 MW	58.8 MW	1,176 MW
Estimated Total Solar Potential from Agriculture					**1,334 MW**

Farm data source: National Agriculture Statistics Service, USDA (2006), Available at http://www.nass.usda.gov/QuickStats

The results of this analysis show that if solar were deployed at this level in California, it would result in 11,698 gigawatt hours (GWh) annually, or about 5 percent of total electricity used in 2006. This level of solar installations would be more than one-third of the Go Solar California goal of 3000 MW and could save farmers millions of dollars in future electricity costs.

The incentive structure for solar installations in California is the most generous in the nation. Coupled with the fact that businesses can also take advantage of net metering, as discussed in Section 2, as well as streamlined interconnection procedures (as compared to many states in the country), it seems that many farms and agribusinesses are not reaping the full energy benefits offered by the Sunshine State.

Barriers to Increased Use of Solar Power in Agriculture

Cost: Solar PV is one of the most expensive renewable energy technologies, at $5 – 8 per watt to install. Though generous rebates and incentive programs help reduce this capital outlay, even a small 2.5 kilowatt PV system can cost $12,500 - $20,000.

Process: Though the Go Solar California program strives to make the process as streamlined as possible, there is much paperwork to be filed to apply for the solar incentives, to interconnect with the utility and to qualify for net metering.

Acceptance: Though California is far ahead of other states in terms of solar energy installations, for individual farms and ranches, it has not yet moved into the mainstream.

Awareness: Though California has very generous incentives, residents may not be aware of the potential long-term cost savings of installing solar systems, and may also not be aware of the incentive programs.

***State Incentives for Solar Power*[11]**

Go Solar California: This consists of two programs, the Expected Performance-Based Buydown, and the Performance Based Incentive

For smaller systems: Expected Performance-Based Buydown
Systems of less than 100 kilowatts receive a one-time, up front incentive, up to $2.50 per watt, based on expected solar energy production. As solar systems can typically range in the $5-8 per watt for equipment and installation costs, this program can reduce the costs of using solar energy by 50%. The program works to the advantage of early adopters, as the incentive declines over a series of 10 steps as the number of solar megawatts increase in the state. As of September 2007, each of the state's three investor-owned utilities had reached Step 2 for residential customers, which still provides the highest incentive level of $2.50 per watt. For business customers, though, both PG&E and Southern California Edison have reached Step 4, which provides $1.90 per watt incentive; indicating that a higher number of watts have been installed for commercial use since the program's inception. The incentive declines to $.20 per watt as the total installations reach 350 MW statewide. [12]

For larger systems: Performance Based Incentives
This program is designed for those who install solar systems of greater than 100 kilowatts. This incentive pays the solar owner monthly, up to 39 cents per kilowatt-hour, based on the actual energy produced for a period of five years. This program also encourages early adoption, as the payment rates decline stepwise to $.03 per kilowatt by the time 350 MW are enrolled in the program. As noted above, the two larger utilities have already reached Step 4, and the payments are now $.26 per kWh for new applicants.

As of January 2007, applicants for both of these programs had to enroll in the Time-of-Use (TOU) metering as required by legislation (S.B. 1). TOU metering charges much higher rates for electricity during daytime hours. This had the unintended effect of actually raising electricity costs for some customers installing solar systems. For example, Southern California Edison charges 29.7 to 35.9 cents per kilowatt-hour between 10 a.m. and 6 p.m. on weekdays, but drops to a range of 16.3 to 18.6 cents per kilowatt-hour from 10 p.m. to 6 a.m. on weekdays and all weekend days and holidays, according to documents filed with the PUC. Some customers found that, if they were not able to fulfill their entire electricity needs with their solar panels, their electric bills actually increased when they installed the systems. The number of applicants for the solar incentives dropped by 75% in the first three months of 2007, as compared with the same time period in 2006.[13]

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[11] More information on all solar incentives can be found at: Database of State Incentives for Renewable Energy, www.dsire.org (updated Sept. 12, 2007) and the California Energy Commission, www.energy.ca.gov

[12] California Solar Initiative. www.gosolarcalifornia.org

[13] Lifsher, M. "Rebate rules chill sales of solar." *Los Angeles Times*. May 28, 2007. p. C 1.

To respond to this issue, Assembly Bill 1714 was passed in early June 2007, which allows the PUC to delay implementation of the mandatory TOU metering until new rate cases are filed in 2009. [14]

Solar PV systems also benefit from California's **net metering** and **renewable portfolio standard policies**, as discussed in Chapter 2.

Property Tax Exemption for Solar Systems
Section 73 of the California Revenue and Taxation Code allows a property tax exemption of 75% of the full cash value for most types of solar energy systems installed on or before December 31, 2009. (The original expiration year of 2005 was extended by AB 1099 [2005].) These include solar space conditioning systems, solar water heating systems, active solar energy systems, solar process heating systems, photovoltaic (PV) systems, and solar thermal electric systems, and solar mechanical energy.

Federal Incentives for Solar Power

Solar Tax Credits
The Federal Energy Policy Act of 2005 provides for a federal investment tax credit of 30 percent of total system cost of a solar system, up to a maximum of $2000 per system. The credit is available to homeowners for solar systems placed in service from January 1, 2006 through December 31, 2008.

The Farm Security and Rural Investment Act of 2002, Section 9006
Farms and rural small businesses are eligible to receive up to a 25% cost-share on solar electricity or solar heat projects.

[14] California Public Utilities Commission. PUC REMOVES MANDATORY TIME-OF-USE RATES FOR SOLAR CUSTOMERS, News Release June 7, 2007. Available at: http://www.gosolarcalifornia.ca.gov/news/2007-06-07_CPUC_NEWS_RELEASE.PDF

Chapter 4 - Wind Energy in Agriculture

California is the birthplace of commercial wind energy. For 20 years, until 2006, California led the nation in wind energy installations, with 2,376 MW installed as of August 2007, and 565 MW planned for installation by the end of the year.[1] New utility-scale wind installations slowed in recent years, and Texas is now the national leader in wind energy, with over 3,300 MW installed, and another 1,200 MW under construction. Wind energy is the fastest growing source of renewable electricity in the country; it has been growing by approximately 25% per year for the past three years. The U.S. currently has 12,634 MW of installed wind energy as of June 2007. Wind energy supplies about 2% of the total U.S. demand for electricity.[2] One megawatt of wind energy can supply the energy needs for 250-300 houses.

California currently sources 1.8% of its electrical energy from wind power, nearly all of which is produced within the state. This wind energy production is reported exclusively from grid-connected, utility-scale systems that are clustered primarily in three areas: Altamont Pass, San Gorgonio Pass and Tehachapi, which account for nearly 95% of commercial wind power in California. Smaller commercial wind installations are found in Solano and Pacheco. Hundreds of smaller scale residential or business wind systems are also scattered across the state, but they are not counted in these figures.

Wind is a geographically specific resource, and many factors affect the power potential of wind turbines. Wind speed is measured from Class 1 to 7, with Class 1 being the lowest at 11 mph or less. Small wind projects, or those categorized as 100 kW or less, can operate at Class 2 winds, which is 11.5 mph. To install commercial-scale turbines, Class 3 wind speeds and higher, or at least 13.3 mph is necessary. The power that wind can produce is also determined by the air temperature; colder wind has more density and therefore generates more power. Height from the ground is a critical factor, as the wind blows faster at higher levels.

Given the state's current policy scenario, California agriculture is poised to benefit primarily from small wind systems, in which the energy produced is used to power their agricultural operations. The agricultural industry can really only participate in commercial-scale projects via long-term lease arrangements for land resources. Wind developers rarely own the land on which they plan to build a project, and thus will lease land from owners for periods of 20 to 30 years. Typical payments are in the range of $4,000 per turbine per year, though these figures can vary widely. These arrangements can bring added income to landowners with very little risk, and in many cases, farming and ranching can continue around the turbines. The land use issue is more prevalent in the Midwest where turbines are likely to be installed on prime agricultural land; in California most of the wind turbines are installed on mountain passes and ridges.

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[1] American Wind Energy Association, http://www.awea.org/projects/california.html

[2] American Wind Energy Association, U.S. Wind Energy Project Map, http://www.awea.org/projects/

California has virtually no locally owned commercial-scale projects, also known as community wind projects. Other states, particularly Minnesota, have enacted policies that enable farmer-owned cooperatives to own small, utility-scale projects of 2 to 5 MW. These installations, which cost from to $6 to $15 million, (current cost is about $3 per watt, installed), are feasible to farmer-owners because of generous standard power purchase contracts, a Renewable Portfolio Standard (RPS) that creates demand for smaller commercial systems, and creative financing models that take advantage of the Production Tax Credit.

When it comes to small wind systems, California has some of the nation's most generous incentives for installing wind projects to power a farm, home or business. Small wind energy is an underutilized resource, as evidenced by the map in Figure 4.1.

Demand for Wind Energy

The demand for wind and most other forms of renewable energy is driven by the policy arena. It is no surprise that the states with the highest level of wind installations (Texas, California, Iowa and Minnesota) are also those that have some of the most favorable policies to encourage wind development. Wind is an intermittent energy source, and many utilities would rather deal with energy loads that are more consistent and controllable. Therefore, unless an RPS exists, or there is some means for consumers to express demand for green energy (usually by paying a higher rate), wind energy typically isn't developed. There is currently no federal renewable electricity standard for utilities, though one is included in a current House energy bill (H.R. 3221, August 2007). The Senate's version of the energy bill did not include a renewable electricity provision. The final version of the bill will be decided sometime in the fall of 2007. Even if a federal RPS is implemented, the current House bill calls for only a 15% mandate; California's standard has already been accelerated to 20% by 2010 and 33% by 2020, so the federal RPS will not have an effect on California's reliance on renewable electricity sources.

With renewable electricity currently providing almost 11% of the current electricity portfolio, the renewable portion of California's electricity will have to nearly double in the next three years to meet the state RPS. Wind will certainly be part of that mix, but is uncertain the extent to which it will increase in concert with other competing renewables, such as biomass and solar. To meet increased demand from the RPS, it is anticipated that the existing wind farms at Altamont Pass, Tehachapi and San Gorgonio Pass will be re-powered as the power purchase agreements end on the 20-year-old turbines. That process has already started. For example, the most of the turbines in each of those wind developments are rated between 50 - 500 kW.[3] These turbines are considered small by today's standards; now the industry standard is a 1.5 MW turbine for commercial developments. In addition to more powerful generators, turbines have been engineered to be more efficient, and the towers are much taller than the ones installed in the 1980s. Modern turbines are usually installed on 60- to 80-meter towers, while early turbines rose

[3] California Energy Commission, California Wind Resources Draft Staff Paper, CEC-500-2005-071D. April 2005

only 20 to 30 meters above the ground. Taller towers mean more power generation from the higher wind speeds that can be captured farther above the ground.

Wind Energy Supply from Agriculture

Based on available wind installation data, no commercial-scale projects are owned by agricultural entities. According to records kept by the California Energy Commission (CEC), the Emerging Renewables Program has funded 372 small wind projects for a total of 2.3 MW.[4] The program limits the size of wind systems to 50 kW or less. The program records show that 211 of these systems were 10 kW Bergey turbines, which is a brand of small wind turbines manufactured in Oklahoma. The program doesn't distinguish residential versus business applications, but it is typically recommended that systems of 10 kW size should be installed on parcels of at least one acre. The zip codes of the installations reported by the CEC indicate a heavy concentration in the southeastern area of the state, primarily in Kern and San Bernardino County locations. None of the state energy or agricultural agencies tracks whether wind systems are specifically installed for agriculture, so it is difficult to estimate how many of these might be powering agribusinesses. None of the 10 California awards for the USDA 9006 Program, the only program that targets agricultural applications of renewable energy, have been slated for wind projects.

Some of the most productive agricultural regions of the state are not in good wind speed areas, according to the wind map in Figure 4.1. The combination of low-lying lands, as well as warm temperatures for much of the year does not allow wind to generate enough power to make installations financially feasible places like Tulare and Fresno Counties. However, there are many other agricultural areas in the state where farms and agribusinesses could benefit from small wind installations.

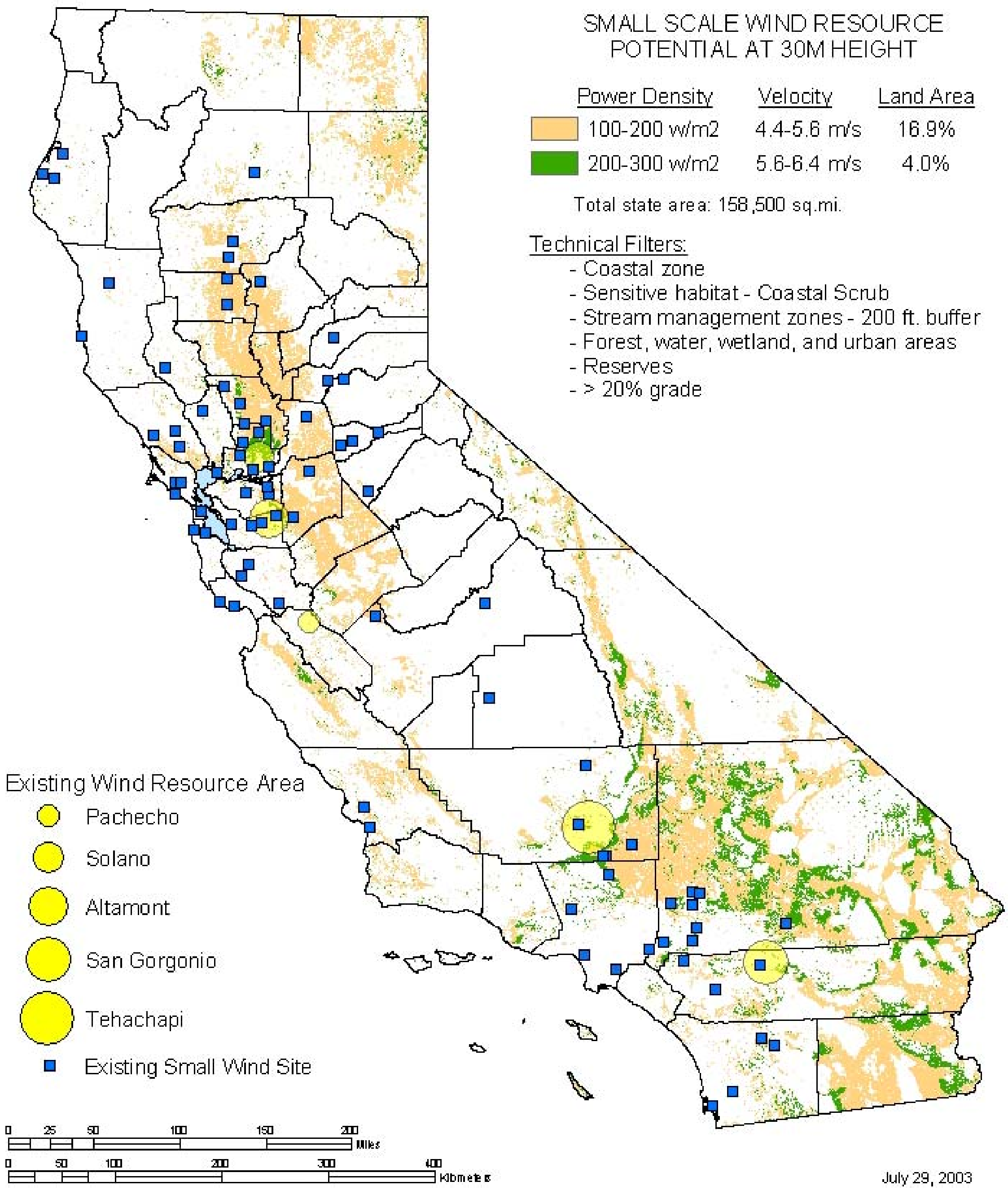
Small Wind Potential in California Agriculture

Wind energy used to be prevalent on most farms and ranches in the U.S.; it was how many rural residents pumped water or generated power before rural electrification. Remnants of these old steel structures still dot the countryside in some areas of California.

Now, modern wind generators are a rarity on farms, despite the fact that the state will offset half of the cost of installation. There is great potential throughout the state for small wind to work, though. Table 4.1 indicates the counties by rank order of those with the most potential for small wind development, based on wind speeds and open space. San Bernardino, Kern, Imperial and Riverside are the top four in terms of small wind potential. Of the top 10 counties listed, three are also in the top 10 for agricultural production - Kern (3), San Diego (7) and Imperial (10). Overall, there are 1.8 million

[4]California Energy Commission, Emerging Renewables Program Account Activity
http://www.energy.ca.gov/renewables/emerging_renewables/index.html

Figure 4.1 Small Wind Potential in California, 30 meters



Source: California Energy Commission, California Wind Resources Draft Staff Paper, CEC-500-2005-071D. April 2005.

Table 4.1 California Wind Potential by County
Based on 2002 California Energy Commission Wind Map Data

COUNTY	ACRES IN WIND CLASS 2-7*	% OF COUNTY IN WIND CLASS 2-7	ACRES WITH PRIME SMALL WIND DEVELOP-MENT POTENTIAL**	COUNTY	ACRES IN WIND CLASS 2-7*	% OF COUNTY IN WIND CLASS 2-7	ACRES WITH PRIME SMALL WIND DEVELOP-MENT POTENTIAL**
San Bernardino	7,075,745	55%	610,514	Yolo	433,990	66%	1,577
Kern	1,588,973	30%	253,198	Monterey	214,720	10%	1,544
Imperial	1,082,929	38%	181,088	Orange	99,737	20%	1,459
Riverside	2,144,764	46%	170,398	Butte	207,861	19%	761
Los Angeles	1,038,075	40%	142,800	Trinity	132,566	6%	740
Solano	428,505	75%	120,651	Colusa	104,854	14%	635
Inyo	2,108,495	32%	112,311	Merced	90,180	7%	616
San Diego	807,947	30%	62,026	El Dorado	69,247	6%	579
Siskiyou	552,615	14%	24,937	Nevada	37,211	6%	494
Ventura	445,338	37%	22,312	San Benito	44,056	5%	447
Alameda	61,480	13%	15,545	Tulare	159,285	5%	443
Santa Barbara	514,992	29%	12,024	Napa	34,977	7%	437
Lassen	474,358	16%	10,035	Placer	61,108	6%	425
Mono	566,010	28%	9,268	Sutter	72,014	18%	292
Mendocino	189,666	8%	7,987	Fresno	130,694	3%	267
Modoc	398,353	15%	5,867	San Mateo	61,647	21%	225
Contra Costa	97,774	20%	5,631	Santa Clara	14,704	2%	217
Shasta	341,459	14%	4,996	Stanislaus	28,750	3%	175
Humboldt	315,672	14%	4,607	Glenn	170,009	20%	116
Plumas	174,705	10%	4,110	Kings	7,184	1%	108
Del Norte	145,231	22%	3,872	Tuolumne	108,706	7%	91
Marin	101,352	30%	3,767	Amador	7,621	2%	83
San Joaquin	64,952	7%	3,526	Calaveras	8,540	1%	69
San Luis Obispo	171,523	8%	2,881	Madera	35,731	3%	57
Sierra	97,198	16%	2,137	Santa Cruz	13,600	5%	7
Tehama	413,119	22%	2,135	San Francisco	12,900	43%	2
Lake	67,725	8%	1,887	Sacramento	102,566	16%	-
Sonoma	91,282	9%	1,782	Mariposa	7,091	1%	-
Alpine	133,647	28%	1,677	Yuba	726	-	-
				TOTAL	24,029,276	24%	1,815,826

* At least 11.5 mph at 30 meters above ground
**At least 13.3 mph at 30 meters above ground (wind classes 3-7); exclusions for urban areas, water bodies, protected land and 20%> slopes.

Source: Permitting Small Wind Turbines: A Handbook. *Learning from the California Experience.* Sept. 2003. Available at: www.awea.org/smallwind.html.

acres in California with sufficient wind to construct at least small wind systems, and many of those acres have potential for utility scale developments as well.

Because of wind's variability and specificity to a location, it is more difficult to estimate the actual potential that could be sourced from agriculture without using GIS data to identify the farmland by zip code that has the best wind resource. As a conservative estimate, if one takes the land suitable for prime wind development, and divides it by the average California farm size of 353 acres, the result is 5,123 farms. That number would be just under 7% of the total number of California farms. If these farms each installed a 10 kW wind turbine, it would result in over 51 MW of renewable energy potential. When compared to the 2,400 MW already produced by utility-scale projects, this doesn't seem very impressive. However, the benefit to agriculture would be decreased energy costs in the long run, energy self-sufficiency and reduced emissions.

If the policies were in place to make it feasible for each of those farms to install a 1 MW wind turbine, then more than 5,000 MW would be added to the renewable energy mix, very swiftly enabling the state to meet the RPS set forth by legislature. This presumption is born out by Figure 4.2, which estimated where the best potential is for new utility-scale wind development, indicated by the darkly shaded counties.

Barriers to further Wind Adoption in California

Though California has very favorable policies to encourage both small and commercial scale wind development, there are a number of barriers to further development. These can be classified as micro-level issues that accrue at the local level, and macro-level barriers that broadly impact wind energy development.

Micro Barriers

Local permitting and zoning: Even with favorable state and federal policies to support wind development, local zoning and planning commission can make it difficult, expensive or impossible to install wind turbines in certain areas. Zoning issues were identified in a national small wind market study as the number one market barrier for small wind turbines.[5] Commercial wind developments can also be stalled by zoning laws.

Interconnection and net metering: Consumers must to work with their utilities to connect their projects to the grid and benefit from net metering, and this requires a great deal of paperwork and patience.

Learning curve: Wind energy isn't feasible everywhere, and potential customers have to conduct a lot of research to learn if a wind system will work for their farm or home.

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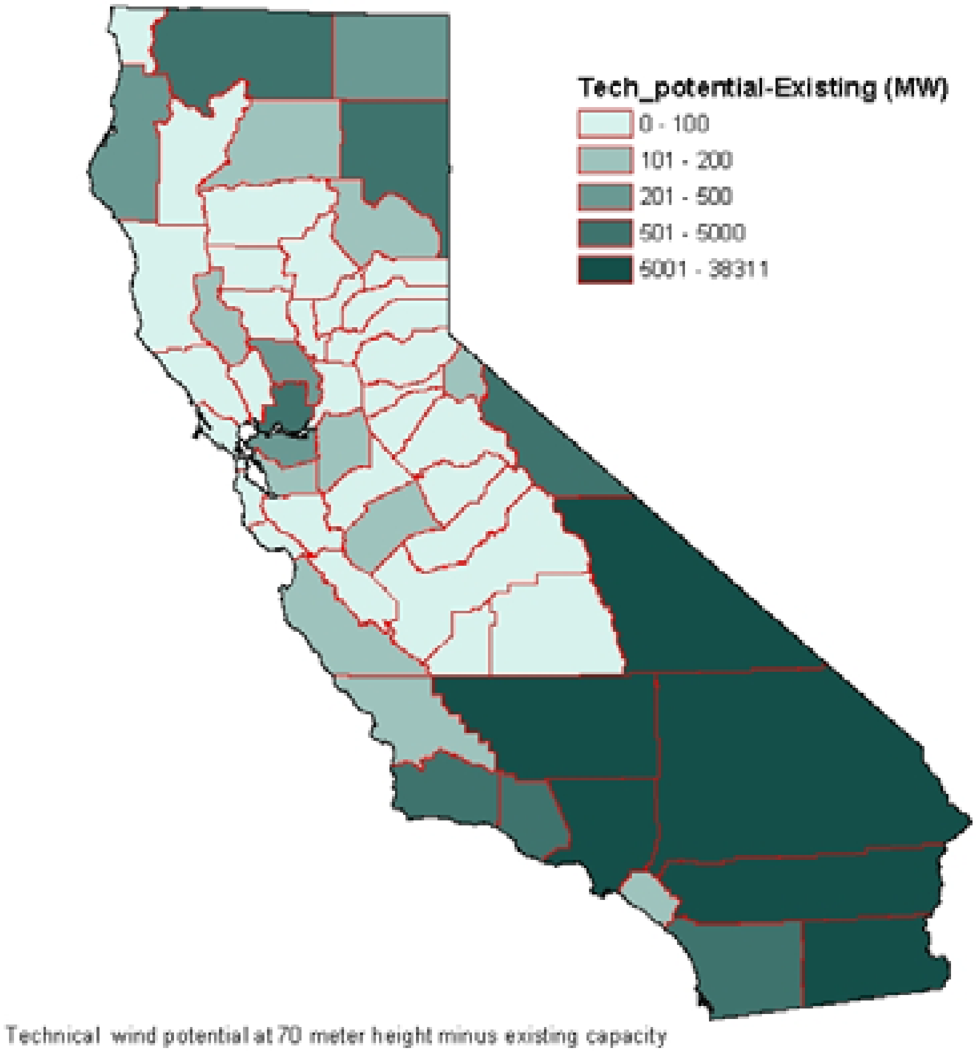
[5] American Wind Energy Association. *Permitting Small Wind Turbines: A Handbook. Learning from the California Experience*. Sept. 2003. Available at: www.awea.org/smallwind.html.

Figure 4.2 Technical Potential for Increased Wind Generation



Source: California Energy Commission, California Wind Resources Draft Staff Paper, CEC-500-2005-071D. April 2005.

Cost to the consumer: A lack of competition in turbine manufacturing, the increasing cost of steel, copper, concrete and other raw materials; and growing demand has kept the price of both small and large wind turbines high, at $5 per watt for small systems and $3 per watt for commercial turbines. Because of these factors, the cost of wind energy installations has actually increased over the past two years.

Understanding the economics of small wind: Small wind systems are long-term, cost-saving investments, and simple payback calculations don't capture the true value nature of the investment. Rebates, net metering rates, current cost of electricity and the efficiency of the wind system are among the factors that can dramatically change the investment returns.

Macro Barriers

Transmission: This barrier transcends wind; it is an important concern of all electric energy developers in the U.S. Grid capacity is already strained, and often, the best places to install large wind developments are in unpopulated areas with limited transmission capability to transfer energy loads to population centers.

Uncertain federal policy: Wind advocates have long argued for stable, long-term wind energy policy, but important policies such as the Production Tax Credit are rarely extended for more than two or three years at a time.

Turbine shortage: Currently there is up to a three-year wait for utility-scale turbines, as worldwide demand has outstripped supply.

Avian impact monitoring: Avian migratory paths must be studied where large wind developments are planned. Small turbines do not present as much of a concern.

State and Federal Incentives – Impact on Wind Development

As most of these policies have been discussed in depth in Chapter 2, only a brief explanation will be provided with examples of how wind energy development is impacted.

State incentives for wind energy

The state incentives for wind energy are divided into two areas: incentives that help to offset the substantial upfront capital costs of wind turbines, and incentives that allow the system owner to benefit from reduced energy costs by improving access to the utilities and receiving retail credit for the energy they offset.

Emerging Renewables Program
Small wind turbines with a rated output of 50 kW or less are eligible, as of January 1, 2007. The rebate is $2.50 per watt for the first 7.5 kilowatts of the system, and $1.50 per watt for the increments of watts greater than 7.5 kW, but less than 50 kW. The electricity

generated can be up to 100 percent of the customer's usage, and the turbine system must have a five-year warranty for the maximum rebate eligibility. A 10 kW Bergey XL, which costs approximately $50,000 to install in California, would qualify for a $25,000 rebate under this program.

The Self-Generation Incentives Program
Wind systems up to 5 MW qualify for this program, which differs from the Emerging Renewables Program in that it is designed to encourage larger scale projects used by a business. The incentive for wind turbines is $1.50 per watt, for turbines between 50 kW and 5 kW. The incentive reaches a maximum at 1 MW. For example, a business that installs a 50 kW Entegrity EW15 wind turbine, which is typically marketed to farms, businesses and schools, could receive a $75,000 rebate on the turbine, which generally costs in the range of $150,000.

This, too, appears to be an underutilized program for wind; since the program's inception in 2001, the program has funded five wind turbine projects, for a total of 3.4 MW. The smallest project was 250 kW, and the largest was just under 1 MW. Only one project appears to have been funded for an agriculturally related project, a business classified as a starch and vegetable fats and oils manufacturing plant in Petaluma.

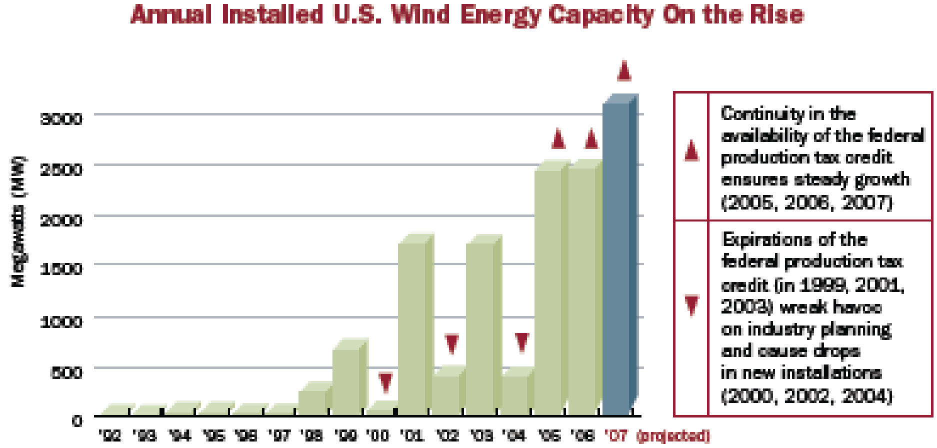
Net metering – smaller systems
Wind and other renewable electricity systems can net meter up to 50 kW. Net metering helps the smaller self-generators to offset the electricity they produce with full retail credit. This can be substantial savings over the usual $.12 - $.14/kWh that utilities charge in California.

Federal incentives

Production Tax Credit, Energy Policy Act of 2005
One of the most important public policies for the development of wind energy across the United States has been the production tax credit for renewable energy. California's early wind projects were developed before the tax credit went into effect, many in the mid-to-late 80s. However, the recent extensions of the tax credit are helping to encourage further development in California, as currently over 560 MW are in the proposal/planning stages.[6] Wind policy advocates note that the uncertain nature of the production tax credit (it has been allowed to expire three times since its inception in 1992) has detrimental effects on the long term development of wind and other renewable electricity sources; see Figure 4.3.

[6] American Wind Energy Association. http://www.awea.org/projects/california.html, updated June 30, 2007.

Figure 4.3 Impacts of Production Tax Credit Extensions and Expirations on Wind



Source: American Wind Energy Association, Annual Wind Outlook 2007.

2002 Farm Security and Rural Investment Act, Section 9006

This grant program provides up to 25% cost share for wind and other renewable energy systems on farms and rural small businesses. California has received only $1.7 million for 10 projects; out of over 1,000 projects that have garnered nearly $100 million nationwide. Only solar and anaerobic digester projects have been funded through this program in California.

Chapter 5 - Electrical Energy Potential of Agricultural Waste Biomass

The use of agricultural waste biomass as a biofuel for the generation of electricity in California is receiving ever greater attention. Governor Schwarzenegger's Executive Order S-06-06 (April 2006) calls for California to greatly increase its share of biofuels production and the generation of electricity from agricultural waste biomass. Agricultural waste biomass is comprised of orchard and vineyard prunings and removals, field and seed crop residues, vegetable crop residues, animal manures, and food processing wastes.

Location of Agricultural Waste Biomass

Figure 5.1 shows that California agricultural waste biomass is distributed throughout California but it is most heavily concentrated in the Central Valley.

Agricultural Waste Biomass Technical Supply

It is estimated that there are 86.0 million gross dry tons per year of biomass produced in California of which 33.6 million dry tons per year are available for thermal conversion to electricity and biochemical conversion.[1] Table 5.1 shows estimated composition of the agricultural waste biomass.

Table 5.1. Estimates of Annually Available Agricultural Biomass, 2005

	Million dry tons/year	
	Gross	Technical
Total Agricultural Waste Biomass	***21.6***	***9.6***
Total Animal Manure	11.8	4.5
Total Orchard and Vine	2.6	1.8
Total Field and Seed	4.9	2.4
Total Vegetable	1.2	0.1
Total Food Processing	1.0	0.8

Source: *Biomass in California: Challenges, Opportunities, and Potential for Sustainable Management and Development*, California Energy Commission report CEC-500-2005-160, June 2005

California agricultural waste biomass accounts for approximately 25% of total gross biomass and 28.6% of the technical biomass. There is currently 21.6 million gross dry tons of agricultural waste biomass produced in California with 9.6 million technical dry

[1]Biochemical conversion refers to conversion systems using biological processes include fermentation to produce alcohols, fuel gases (such as methane by anaerobic digestion), acids and other chemicals, and aerobic processes used for waste stabilization and composting. Combustion, thermal gasification, and pyrolysis are classified as thermo conversion. Products include heat, fuel gases, synthesis gases, ammonia, hydrogen, and alcohols.

Figure 5.1. Location of California agricultural waste biomass (dry tons)

Source: *Biomass in California: Challenges, Opportunities, and Potential for Sustainable Management and Development*, California Energy Commission report CEC-500-2005-160, June 2005 tons available for electrical energy production.[2] Thus about 47% of total agricultural waste biomass is technically available for energy production. Animal manure accounts for 47% of that technically available total followed by crop waste biomass at 45%, and food processing waste accounts for 0.8%.

The Dairy Power Production Program (DPPP) is currently supporting efforts to use manure from for electrical energy production. The purpose of the DPPP is to encourage the development of biologically based anaerobic digestion and gasification ("biogas") electricity generation projects on California dairies. Objectives of the program include developing commercially proven biogas electricity systems that can help California dairies offset the purchase of electricity, and providing environmental benefits by reducing air and ground water pollutants associated with storage and treatment of livestock wastes. The program has already funded 10 methane digester projects with an estimated generating capacity of 2.5 MW, and nine more have been approved for completion by March 2008, adding another 1.33 MW. More specific information about this incentive program is discussed in the incentives section.

Close to 1 million tons per year of prunings and tree removals from orchards and vineyards are currently used as fuel in direct combustion power plants, generally blended with other fuels such as urban wood and forest materials. Field crop waste biomass is principally cereal straws and corn stover. These materials are not currently used for power generation due to problems with ash slagging and fouling in combustion systems. Vegetable crop residues are not generally considered for off-field utilization and are commonly incorporated into the soil. Food processing operations in the state produce a variety of biomass feedstock including nut shells, fruit pits, rice hulls, cotton gin trash, meat processing residues, grape and tomato pomace, beet residue, cheese whey, beverage wastes, and waste water streams containing sugars and other degradable materials. A number of food processing residues are used for power generation. At least 250,000 tons per year are presently used for power generation, mainly from rice hulls and shells and pits.

Current and Future Electricity Generating Potential from California Agricultural Waste Biomass

There are a total of 978 electricity power plants in California with an operational capacity of 0.1 MW or greater. Thirty-one of those plants utilize some type of biomass as a component of their primary power. Table 5.2 shows the location and generating capacity of the seven power plants that indicate the use of agricultural waste biomass as part of the primary fuel.

[2]Gross resource refers to the estimated total annual biomass produced. Technical resource refers to the amount that can potentially be supplied for thermal and biochemical conversion to energy products. The total gross amount of agricultural waste biomass cannot be used for energy production for several reasons. These reasons include maintaining soil fertility and tilth, erosion control, terrain limitations, environmental and ecosystem requirements, collection and transportation costs, and other technical and social constraints.

Table 5.2. Location and Generating Capacity of California Power Plants Utilizing Agricultural Waste Biomass

PLANT NAME	GENERAL FUEL	PRIMARY FUEL	COUNTY	YEAR ONLINE	ONLINE MW
MESQUITE RESOURCE RECOVERY PROJECT	BIOMASS	AG. & ANIMAL WASTE	IMPERIAL	1988	17.89
MECCA PLANT	BIOMASS	AG. & WOODWASTE	RIVERSIDE	1991	49.90
WOODLAND BIOMASS POWER LTD	BIOMASS	AG. & WOODWASTE	YOLO	1989	28.00
MADERA POWER LLC	BIOMASS	AG. & WOODWASTE	MADERA	2001	25.00
PACIFIC OROVILLE POWER INC.	BIOMASS	AG. & WOODWASTE	BUTTE	1985	18.75
DIAMOND WALNUT	BIOMASS	AG. WASTE	SAN JOAQUIN	1981	5.00
WADHAM	BIOMASS	RICE BY PRODUCTS	COLUSA	1990	29.07

The source of this data is the California Energy Commission 2007 California Power Plant Database (www.energy.ca.gov/database/index.html#powerplants)

These seven power plants have 173.6 MW of online energy capacity. That represents 25.2% of the total MW capacity of all biomass energy plants and 0.18% of the total MW capacity of all power plants in California.

The potential generating capacity of electric power generation from California biomass and California waste biomass is shown in Table 5.2. The gross biomass resource in the state would be sufficient to generate 10,711 MW of electricity with more than 2,144 MW from agriculture. However, as previously discussed not all biomass or agricultural waste biomass can be used for power generation. The current technical biomass potential is 4,654 MW with agricultural waste biomass accounting for 1,021 MW or 22% of that technical potential.

Table 5.3. Estimated Electricity Generating Potential from Biomass and Agricultural Waste Biomass in California, 2005 Resource Base

	Potential MW		Potential GWh		Existing/Planned		Net Technical	
					MW	GWh	MW	GWh
	Gross	Technical	Gross	Technical				
Total Biomass	**10,711**	**4,654**	**79,757**	**34,650**	**969**	**7,216**	**3,684**	**27,434**
Possible Use by Thermal Conversion	8,536	3,671	63,561	27,337	644	4,796	3,027	22,541
Possible Use by Biochemical Conversion	2,175	982	16,196	7,313	325	2,420	657	4,893
Total Agriculture Waste Biomass	**2,144**	**1,021**	**15,964**	**7,605**	**141**	**1,051**	**880**	**6,554**
Total Animal Manure	986	389	7,339	2,893	4	30	385	2,863
Total Orchard and Vine	346	242	2,573	1,801	93	694	149	1,108
Total Field and Seed	575	281	4,281	2,092			281	2,092
Total Vegetable	112	9	835	70			9	70
Total Food Processing	126	101	936	749	44	328	57	421

Source of information is Table 6.2 page 35 *in Biomass in California: Challenges, Opportunities, and Potential for Sustainable Management and Development,* California Energy Commission report CEC-500-2005-160, June 2005.

The 1,021 MW of technical agricultural waste biomass capacity would generate 7,605 GWh of electrical energy or about 3% of the 283,000 GWh of electricity currently used in the state. The existing or planned total biomass technical generating capacity is 969 MW with agricultural waste biomass contributing 141 MW or 15% to the total biomass technical generating capacity.[3]

The net technical potential for agricultural waste biomass is 880 MW. That 880 MW would produce an additional 6,554 GWh in electrical energy or 2% of the 283,000 GWh of electricity currently used in California.

Barriers to Increased Use of Agricultural Waste Biomass for Electricity Generation in California

The three greatest barriers to the increased use of agricultural waste biomass for electricity generation in California are the same as those that are generally stated of any biomass supply for the production of energy. These barriers include[4]:

[3] Note that in Table 6.3 the estimated existing/planned agricultural biomass waste energy capacity based on the 2005 resource base is 141 MW as compared to 2007 agricultural waste biomass generating capacity of 173.6 MW as shown in Table 6.2. The difference can be attributed to the fact that the data contained in Table 6.3 is the estimated generating capacity for agricultural waste biomass while the data contained in Table 6.2 shows the generating capacity for power plants that utilize combinations of agricultural waste biomass and wood waste biomass. Additionally, Table 6.3 does not indicate any generating capacity for field or seed production biomass while Table 6.2 shows generating capacity for rice by-products.

[4] These barriers and possible ways to overcome them are discussed in detail in *Biomass in California: Challenges, Opportunities, and Potential for Sustainable Management and Development*, California Energy Commission report CEC-500-2005-160, June 2005.

Cost Barriers

- Cost of fuel or feedstock and security and reliability of supply
- Cost of conversion
- Competition with vested utility, fuel, and waste management infrastructures
- Difficulty in obtaining long term contracts and power purchase agreements to secure financing
- Lack of predictable state and federal management programs
- Lack of stable long term economic and financial incentives and compensation for public benefits provided

Policy Barriers

- Locating Appropriate Sites and Permitting
- Uncertainties in environmental performance for new technologies
- Lack of coordination among jurisdictional agencies
- Utility interconnection for electric power generators

Public Perception

- Lack of public awareness and advocacy
- Limited training opportunities for skilled personnel needed for larger scale development

Federal and State Programs that Support the Use of Biomass for Energy Production

The following lists programs that support the use of biomass including agricultural waste biomass for electrical energy production.[5] Other broad-based programs that include biomass were discussed in Chapter 2.

<u>Federal Programs</u>

The Biomass Research and Development Act of 2000
The Act sets policy to develop a comprehensive national strategy stimulating the development and use of bioenergy and bioproducts through research, development, and private sector incentives. The Act authorized the U.S. Department of Agriculture (USDA) and the Department of Energy (DOE) to jointly operate a grant program that provides funds for research on bio-based products. One example of a California project funded by this project is the Hayfork Biomass Utilization and Value Added Model for Rural Development project in California that received about $503,000 to support the design and early implementation phases of a biomass utilization facility, including a log sort yard, small log processor, and wood-fired electrical generation plant.

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[5] These programs are listed in greater detail in Moller, R.M., *Brief on Biomass and Cellulosic Ethanol.*, California Research Bureau, California State Library, CRB 05-010, December 2005.

State-Level Programs

Although not a definitive program Governor Schwarzenegger issued **Executive Order S-06-06** in April 2006. The executive order specifies certain directions to be taken by state agencies to increase the use of biomass from agriculture, forestry and urban wastes to provide transportation fuels and electricity to satisfy California's fuel and energy needs. The executive order in part states that greater use of biomass for electricity production will meet a 20 percent target within the established state goals for renewable generation for 2010 and 2020. The California Assembly and Senate have introduced a number of bills that specifically call for increased use of biomass for California energy production and several of these include provisions that provide economic incentives.

Dairy Power Production Program[6]

The California Energy Commission (CEC), acting under authority of the Legislative enactment in 2001 of SB5X (Section 5(b)(5)(C)(i)), appropriated and encumbered $9,640,000 for the Dairy Power Production Program (DPPP). Two types of assistance were made available for the grant program: Buydown grants, which cover a percentage of the capital costs of the proposed biogas system, and incentive payment grants for generated electricity. Buydown grants cover up to 50 % of the capital costs of the system based on estimated energy production, not to exceed $2,000 per installed kilowatt, whichever is less. Electricity generation incentive payments are based on 5.7 cents per kilowatt-hour of electricity generated by the dairy biogas system, which totals the same amount of a buydown grant paid out over five years.

The program has funded 10 methane digester projects with an estimated generating capacity of 2.5 megawatts. The projects installed to date have herd sizes ranging from 245 to 6,000 head and are located throughout California, from Marin County to San Diego County. Individual systems have an electricity production capacity ranging from 75 kilowatts to over 550 kilowatts. A program extension in late 2006 made a second round of funding available for new projects. Nine more methane digester construction projects have been approved through the extended program. It is estimated the projects will have a generating capacity of 1.33 megawatts when completed by March 31, 2008. Once completed, individual systems are expected to produce anywhere from 25 kilowatts to 400 kilowatts.

Renewable Portfolio Standard

Established by California Senate Bill 1078 the law mandates 20 percent of retail electricity sales to come from renewable resources by the year 2017. However, although the RPS stimulates renewable energy development, it does not guarantee an increasing use of biomass in competition with other renewables such as wind and geothermal.

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[6]Further details of this program are available through the Western United Development Co., available at http://www.wurdco.com/DPPPbackgrounder.htm.

The Renewable Resources Trust Fund
This is a Public Benefits Fund initially established in the amount of $540 million by AB 1890 (1996) and extended through 2012 by AB 995 (2000) with an additional $1.35 billion. The trust fund manages four accounts including the Existing Renewable Facilities Program, which is the only program applicable to biomass, is funded at $15 million annually. It provides production incentives, based on kilowatt-hours generated, to support existing solid-fuel biomass renewable energy facilities.

Exemptions Established to Reduce Emissions from Agricultural Practices
SB 700 (2003) stimulates the use of biomass conversion systems, (especially dairy manure digesters) by permitting exemptions for agricultural equipment and requiring air quality and air pollution control districts that are federal non-attainment areas to adopt and implement control measures to reduce emissions from agricultural practices, including confined animal facilities such as dairies and feedlots.

Elimination of Agricultural Open Burning
SB 705 (2003) eliminates agricultural open burning within the San Joaquin Valley Air Pollution Control District after specified dates beginning in 2005. By eliminating burning, SB 705 also potentially eliminated emission credits that were applicable to open burning.

The Agricultural Biomass to Energy Program
Established by SB 704 (2003) this program has a $6 million Renewable Resources Trust Fund. The program provided a $10 per green ton subsidy for qualified agricultural biomass converted to energy between July 2003 and June 2004. The subsidy applied only to new agricultural biomass at least 10 percent above the five year average purchase amounts for the facility. SB 704 also repealed the former Agricultural Biomass-to-Energy Incentive Grant Program administered by the Department of Trade and Commerce through 2002.

The Rice Straw Tax Credit Program
Established by SB 38 (1996), this program is administered by the California Department of Food and Agriculture and encourages the development of off-field uses of rice straw as alternatives to field burning or in-field disposal. Eligible purchases of rice straw can be made through 2007. The program is in effect until December 1, 2008. The aggregate amount of the tax credits granted to all taxpayers cannot exceed $400,000 per calendar year. Certificates are issued in order of receipt. The credit of $15 per ton of rice straw is allowed against net tax.

The Rice Straw Utilization Grant Program.
AB 2514 (2000) was established to facilitate the development of off-field uses of rice straw. It provides grants for processing, feeding, generating energy, manufacturing, controlling erosion, and other environmentally sound purposes other than open-field burning.

Low Interest Loans
The California Pollution Control Financing Authority provides low-interest loans to small businesses from a minimum of $1 million up to $20 million for waste-to-energy, resource recovery and landfill projects through the Small Business Assistance Fund's tax-exempt bond program. SAFE-BIDCO provides low interest loans to small businesses of up to $250,000 for energy efficiency and renewable energy systems through the Energy Efficiency Improvements Loan Fund.

It is likely that the 2007 Farm Bill and 2007 Energy Act will contain significant amounts of funding for biomass energy research, loans, grants, and economic incentives. Additionally, there are 23 different biomass energy bills that are moving through California Assembly and Senate committee that will also provide funding for biomass energy research, loans, grants, and economic incentives.

Utility Program

Standard Rate Contract, Southern California Edison Company (SCE)
This investor-owned utility offers a production incentive to customers who generate electricity with eligible biomass-energy systems, including agricultural biomass. Separate contracts are available to facilities with capacities of less than 1 MW (MW), facilities greater than or equal to 1 MW but not greater than 5 MW, and systems greater than 5 MW but not greater than 20 MW. The seller may select a term of 10, 15 or 20 years. The production incentive payment varies from $80.80 per megawatt-hour (MWh) to $93.93 per MWh, depending on the term length and year of production. All renewable-energy credits (RECs) belong to SCE. This contracting option, introduced in May 2007, will remain open until December 31, 2007, or the date on which SCE has signed contracts totaling 250 MW, whichever comes first.

Chapter 6 - Renewable Transportation Fuels from Agriculture

Ethanol and biodiesel are the primary renewable energy transportation fuels that can be produced from agriculture, and will be the focus of the renewable fuels section of the report. As Californians have more vehicles on the road than any other state, and are already the largest consumers of ethanol in the country, the various proposals to increase reliance on imported sources of fuel have been coming from many directions – the President, the Governor, and various legislative initiatives at both the state and federal levels.

As will be discussed in the renewable fuels sections, demand for biofuels in California far outstrips supply, particularly for ethanol. The state has recently enacted legislation to further encourage production of energy from renewable sources, both as a means to become less dependent on fuel sources from other states and nations, but also to mitigate greenhouse gas (GHG) emissions. California now has the strictest laws in the nation regarding greenhouse gas mitigation, and renewable fuels are viewed as one means to reach those ambitious targets.

State Policies to Support Renewable Fuel Production and Use

Executive Order S-3-05
Signed in June 2005, this order established the following greenhouse gas emission reduction targets for California: by 2010, reduce GHG emissions to 2000 levels; by 2020, reduce GHG emissions to 1990 levels; by 2050, reduce GHG emissions to 80 percent below 1990 levels. [1]

Executive Order S-06-06
This order, signed in April of 2006, establishes goals for California to use biomass resources from agriculture, forestry and urban wastes to produce transportation fuels and electricity. In order to increase the use of biomass in fuel production, the state will produce a minimum of 20% of its biofuels by 2010, 40% by 2020, and 75% by 2050. It is important to note that is a production goal, not a renewable fuels standard that mandates consumption. The Air Resources Board and the California Energy Commission, in conjunction with other agencies will continue to participate on the Bioenergy Interagency Working Group in order to prepare a Bioenergy Action Plan. The Bioenergy Action Plan will include research and development of commercially viable biofuels production and advanced biomass conversion technologies; evaluate the potential for biofuels to provide a clean, renewable source of hydrogen; and increase the

[1] Schwarzenegger, Arnold. Executive Order S-3-05. 2005); Available from http://gov.ca.gov/index.php?/executive-order/1861

purchase flexible-fuel vehicles to 50% of total new vehicles purchased by state agencies by 2010.[2]

The California Global Warming Solutions Act requires the California Air Resources Board, and other agencies, to adopt regulations that require limiting statewide greenhouse gas emissions to 1990 levels by 2020 and to regulate the reporting and enforcement (including fees) for greenhouse gas emissions. (Assembly Bill 32, 2006) [3]

Tax Incentive to Use E-85 or Higher Ethanol Blends
In California, the state gasoline excise tax of 18 cents per gallon applies to ethanol/gasoline blends. However, E85, or 85% ethanol blends, are taxed at one-half of that rate. At this point, E85 is not readily available in California so the incentive has not been fully utilized. California Revenue and Tax Code 8651.8 provides for this tax incentive.

California Reformulated Gasoline (CaRFG)
Both the federal and state governments have requirements for RFG. The amendments to the federal Clean Air Act (CAA) in 1990 implemented a wintertime oxygenate requirement of gasoline at 1.8 to 2.2 percent oxygen content, measured by weight. This was implemented in order to reduce the emissions of nitrogen oxides. The federal requirement is at least 2 percent oxygen and still applies in most of Southern California and Sacramento, which accounts for about 70 percent of the gasoline that is used statewide. California's reformulated gasoline requirement was instated in three phases. The third and final stage began on January 1, 2004. It prohibits the intentional blending of MTBE into California gasoline, and ethanol is now the only oxygenate used.

Ban on Use of MTBE
On March 25, 1999, Executive Order D-5-99 was released which ordered the removal of Methyl Tertiary-Butyl Ether (MTBE) from California gasoline as it was found to be a groundwater contaminant. The initial phase-out period to be completed by December 31, 2002, but a one-year extension was granted to December 31, 2003. Ethanol replaced MTBE as the oxygenate in California gasoline. Due to this legislation, most of the fuel in the state of California now contains 5.7% ethanol, making California the largest ethanol fuel market in the United States

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[2] Schwarzenegger, Arnold. Executive Order S-06-06. 2006 (cited 2007); Available from http://gov.ca.gov/index.php?/executive-order/183/

[3]California Global Warming Solutions Act, AB 32, Nunez and Pavely, Statues of 2006.

Federal Policies to support production and consumption of renewable fuels

Both carrot and stick approaches are apparent in the long list of federal policy tools used to increase the consumption and production of renewable fuels. "Carrots" include many incentives provided by the Energy Policy Act of 2005 and the 2002 Farm Bill; while "sticks" have been administered in the form of air and water quality regulations that restrict gasoline additives. Both approaches have set a clear path for the adoption of ethanol and other renewable fuels into the U.S. and California fuel supply.

The **Energy Policy Act of 2005** (H.R.6), was instrumental in setting the stage for increased use of renewable and alternative fuels. The primary provisions specifically targeting biofuels are as follows

- **Renewable Fuels Standard (RFS)**: Set a mandate for the use of 4 billion gallons of renewable fuels in gasoline blends by 2006, increasing to 7.5 billion gallons of renewable fuels by 2012. Ethanol produced from cellulosic biomass or waste is counted as 2.5 gallons toward the RFS.

- **Refueling Station Incentives**: Fueling stations can receive a 30% tax credit for the cost of installing refueling equipment which provides fuel that is at least 85% ethanol blend. This is effective through the end of 2010.

- **Purchase of Alternative Fuel Vehicles**: Businesses and consumers who purchase alternative fuel vehicles (AFV) can receive a tax credit of $2000-$40,000. The amount is dependent on the weight of the vehicle. This also includes provisions for municipalities and schools that purchase alternative-fuel vehicles.

- **Advanced Fuel Vehicle Program.** Operating under the current Department of Energy "Clean Cities" program, this program provides $200 million in grants to state and local governments to acquire alternative-fuel and fuel-cell vehicles, hybrids, and other vehicles, including ultra-low sulfur diesel vehicles.

- **Small Ethanol Producer Credit**: Gives small ethanol producers of 60 million gallons or less, a tax credit of 10 cents per gallon for the fuel that they produce. This is in effect through December 31, 2008.

- **Small Agri-Biodiesel Producer Credit:** Biodiesel producers who produce agri-biodiesel (biodiesel from first-use vegetable oils and animals fats) and have production capacity less than 60 million gallons qualify for a 10-cent tax credit for each gallon of agri-biodiesel produced.

- **Grant and Loan Guarantees for Advanced Biofuels**. Up to $250 million in grant and loan guarantees are available to fund up to four cellulosic and sucrosederived ethanol plants with minimum annual production capacities of 30 million gallons.

- **Grants for Production Facilities**. In fiscal year (FY) 2006, $100 million of grants were authorized, FY 2007 $250 million, and $400 million in FY 2008 to merchant producers of cellulosic biomass ethanol, waste-derived ethanol, and approved renewable fuels.

- **Advanced Biofuels Technology Program:** Provides $110 million in funding for each fiscal year 2005-2009 for research and development of least four conversion technologies for cellulosic biomass ethanol. It also includes not less than five technologies for co-producing value-added bio-products. The projects will be evaluated through a merit-reviewed, competitive process and are subject to cost sharing.

- **Loan Guarantees for Commercial Demonstration Projects:** Guarantees will be provided for up to $50 million for each project that uses sugarcane, bagasse, or sugarcane by-products to produce ethanol.

- **Conservation Reserve Program Biomass Harvest**: Allows for biomass to be harvested from CRP-enrolled land to be used for cellulosic ethanol production. It also provides funding for research and development of bio-fuels and bio-based chemicals.

Volumetric Ethanol Excise Tax Credit (VEETC)
Also referred to as the “”blender’s credit,” this tax credit provides a tax refund to the blender of $.51 per gallon of ethanol that is blended with gasoline at any percentage level. This credit, enacted through the American Jobs Creation Act of 2004, extended previous ethanol tax incentives through the year 2010.

Biodiesel VEETC Tax Credit
The American Jobs Creation Act of 2004 also included biodiesel in the VEETC. The Energy Policy Act of 2005 extended the credit through December 31, 2008, and creates a similar tax credit for renewable diesel. The volumetric excise tax credit varies depending on the biodiesel feedstock, as follows:

- The **Agri-Biodiesel tax credit** is $1.00 per gallon. Agri-Biodiesel is defined as diesel fuel made from virgin oils derived from agricultural commodities and animal fats.
- The **Biodiesel tax credit** remains at 50¢ per gallon. Biodiesel is defined as diesel fuel made from agricultural products and animal fats.
- The **Renewable Diesel tax credit** is $1.00 per gallon. Renewable diesel fuel is derived from biomass using a thermal depolymerization process.

Import Tariff on Ethanol (Omnibus Budget Reconciliation Bill of 1980)
The tariff of $.54 per gallon on imported ethanol has a complicated history. Ethanol imports are actually subject to two tariffs; the standard ad valorem tariff of 2.5% faced by most imported products, and the secondary tariff of $.54/gallon. As part of the 1978 Energy Tax Act, ethanol received a partial exemption from excise taxes. In 1980, P.L 96-223 changed the ethanol excise tax exemption to tax credit, now set at $.51 per gallon via subsequent legislation. The IRS ruled that the tax credit applied to ethanol from both domestic and imported sources that are blended into gasoline. In reaction, and in order to lend more support to the domestic ethanol industry, Congress passed the additional tariff on imported ethanol of $.54/gallon the same year (P.L. 96-499).

The tariff is often referred to as the Brazilian ethanol import tariff, though it isn't specifically targeted at that country. Brazil is the world's largest exporter of ethanol, and thus the tariff is paid primarily by that country's ethanol refineries.[4]

The Farm Security and Rural Development Act of 2002 (Farm Bill)
There are two provisions which encourage ethanol production. 1) Lands which have been placed in the Conservation Reserve Program may be used for wind energy generation and the collection of biomass for energy production. 2) It also provides funding for research and development projects to produce ethanol using non-traditional biomass feedstock. Title IX of the Farm Bill calls for $14 million annually through the year 2007 for biomass research and development. It also built upon the prior Bioenergy Program, reauthorizing up to $150 million annually to help expand the production of bioenergy and increase production capacity for eligible feedstock. Section 9006 also has funds to support the upstart of biofuels refineries. There is $23 million available annually from the CCC through fiscal year 2007.

Clean Air Act Amendments of 1990

- **Leaded Fuel Prohibition**
  Lead has not been allowed as a gasoline octane-enhancing additive since December 31, 1995. Many producers chose to replace the lead with ethanol in order to increase the oxygenate rating and decrease emissions.

- **Reformulated Gasoline (RFG)**
  Cities with the worst smog pollution were required use reformulated gasoline starting in 1995. The Act specified that the RFG contain oxygen in the amount of 2 percent by weight. Ethanol and MTBE have been the most commonly used oxygenates, but many states, including California, banned MTBE. The Energy Policy Act of 2005 (H.R. 6) removed the national oxygenate requirement 270 days after enactment, in lieu of a nationwide renewable fuels standard (RFS).

[4] Renewable Fuels Association, http://www.ethanolrfa.org/resource/facts/trade/

- **The Clean Fuel Fleet Program**
  This program focuses on cities that have ozone and carbon monoxide non-attainment areas and requires that such cities promote vehicles that meet the clean fuel emissions standards.

The Alternative Motor Fuels Act of 1988
This act was extended by the Automotive Fuel Economy Manufacturing Incentives for Alternative Fuel Vehicles Rule of 2004. Beginning in 1990 it encouraged the production of motor vehicles capable of running on alternative fuels. Automobile manufacturers receive up to a 1.2 mpg credit toward the corporate average fuel economy (CAFE) for each model that will run on alternative fuels.

Pending Federal Energy Legislation:

H.R. 3221, New Direction for Energy Independence, National Security and Consumer Protection Act and the Renewable Energy and Energy Conservation Tax Act of 2007 was passed on August 4, 2007. The Senate approved its version of H.R. 6, the Renewable Fuels, Consumer Protection and Energy Efficiency Act of 2007 on June 21, 2007. Both bills cover a wide range of energy topics with extensive attention to ethanol and biodiesel.

However, major differences exist between the two bills, and the compromise bill must be hammered out in conference committee. Some key differences in the bills are as follows:

- Senate version – raised average fuel efficiency to 35 mpg, as well as increase the minimum level of ethanol consumption nationwide; the House version does not include either provision

- House version – includes a federal renewable electricity standard, and provided tax incentives for renewable resources and energy efficiency, while raising royalty payments and taxes on oil companies. The Senate did not adopt any tax package.

For a more complete discussion of these differences as well as the provisions for biofuels in each bill, see the Congressional Research Service publication “Biofuels Provisions in H.R. 3221 and H.R. 6: A Side-by-Side Comparison,” August 21, 2007.

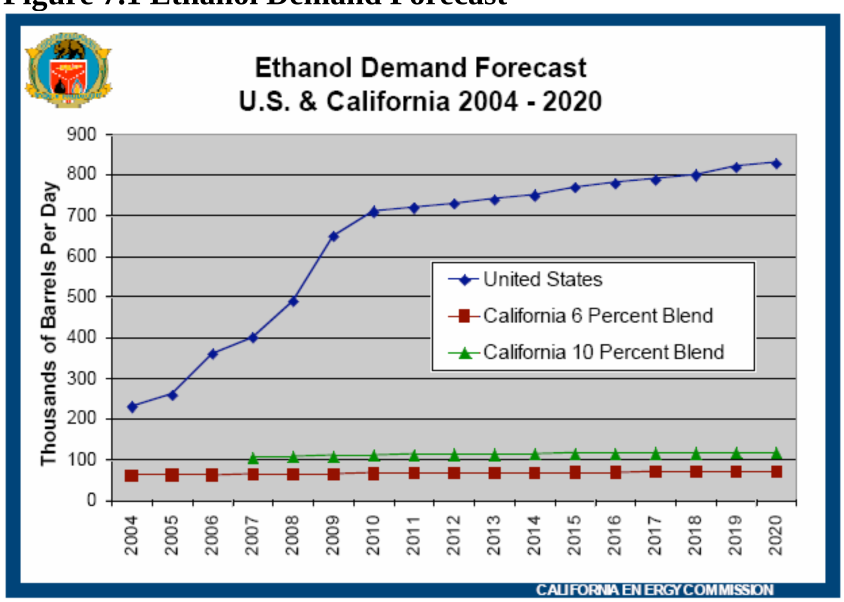
Chapter 7 - Ethanol

California is the nation's largest ethanol consumer, but much of the corn-based fuel currently arrives on rail from the Corn Belt. To produce ethanol, corn grain is processed to remove the sugar in wet and dry mills (by crushing, soaking, and/or chemical treatment), the sugar is fermented, and the resulting mix is distilled and purified to obtain anhydrous ethanol. Major byproducts from the ethanol production process include dried distillers' grains and solubles (DDGS), which can be used as animal feed. Ethanol can be produced from energy crops that are cultivated and harvested for ethanol production or from biomass waste and residue feedstock. Most world ethanol production is made from sugar cane and corn.[1]

California's Demand for Ethanol

In 2006 California used 951 million gallons out of a total U.S. demand of nearly 5.4 billion gallons, which accounted for 17.6 percent of the U.S. total.[2] Current demand for ethanol in California comes primarily from it being blended in nearly all of the state's gasoline at an average concentration of 5.7 percent by volume. Figure 7.1 shows the projected demand for ethanol in the U.S. and California under the current blend scenario, as well as an increased blend to 10 percent ethanol.

Figure 7.1 Ethanol Demand Forecast



Source: Schremp, Gordon. "Ethanol in California Security of Supply." California Energy Commission, Fuel and Transportation Division. January 10, 2007

[1] Energy Information Administration. Biofuels in the Transportation Sector. Available from http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

[2] Renewable Fuels Association, Industry Statistics 2006 (cited in 2007). www.ethanolrfa.org

The future demand for ethanol in California depends largely on the percentage blend that is used. Gasoline demand is forecast to increase at a rate of 0.9 percent per year; assuming that this trend resumes, by 2020 California's ethanol demand could reach 1.1 billion gallons with the traditional 5.7 percent blends. This number could be increased to 1.8 billion gallons by 2020 if the blend requirement increases from 6 percent to 10 percent blends of ethanol. The possibility of California expanding its use of E85 and incorporating ethanol in diesel fuel could increase demand to over 2 billion gallons per year by 2020.

Currently it would be difficult to expand the use of E85 without building additional infrastructure. It would also require additional E85 stations: as of 2007, there is one E85 station open to the public in the entire state. In 2006 there were 257,318 licensed flex fuel vehicles (FFV) in California which would be capable of using E85.[3]

Ethanol Production

As of July 2007, California had annual production capacity of about 120 million gallons of ethanol, as shown in Table 7.1, primarily from corn imported from the Midwest and food processing waste. As shown in Figure 7.2 California's production level represents about 10 percent of the state's current demand for ethanol. Additional projects under construction will bring the in-state production capacity to at least 240 million gallons by 2009. A number of other projects are in the advanced planning and financing stages, which could bring the total production in California to over 670 million gallons by 2012.[4]

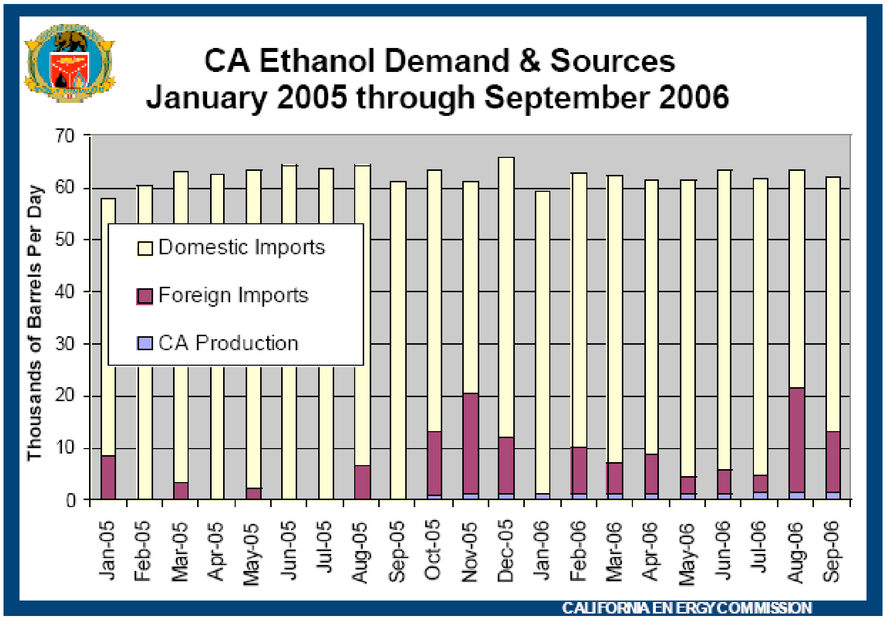
Table 7.1 Ethanol Plants in California

Company	**Location**	**Feedstock**	**Production Capacity (millions of gallons)**
Altra Biofuels	Goshen, CA	Midwest Corn	25
Golden Cheese Co	Corona	Cheese Whey	5
Pacific Ethanol	Madera	Midwest Corn	35
Cilion Ethanol	Keyes, CA	Corn	50
U.S. Liquids	Rancho Cucamonga	Beverage waste	6
Under Construction			
BlueFire Ethanol	Irvine	Midwest Corn	24
Pacific Ethanol	Calipatria	Midwest Corn	50
Pacific Ethanol	Stockton	Midwest Corn	50

Source: Renewable Fuels Association, Industry Statistics. http://www.ethanolrfa.org/industry/locations/. Updated Sept. 28, 2007

[3] American Coalition for Ethanol. "STATUS '07: A State By State Handbook."
[4] California Energy Commission, *Transportation Energy Forecasts for the 2007 Integrated Energy Policy Report*. CEC-600-2007-SD. July 2007.

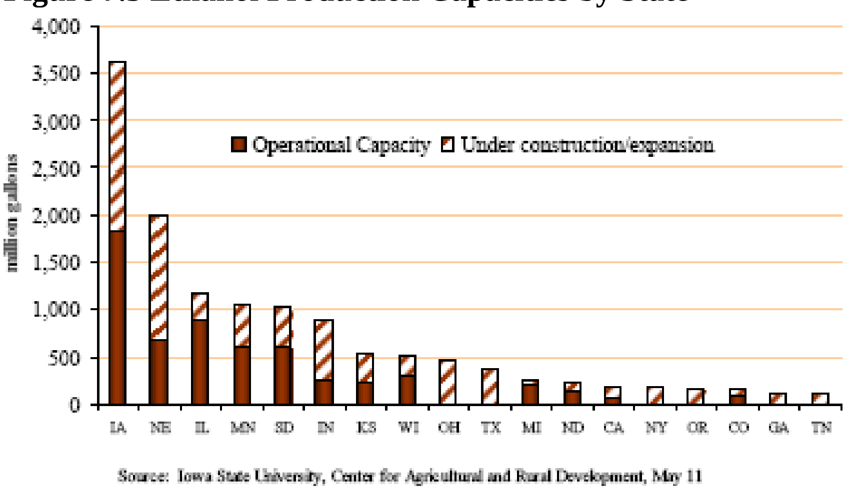
Figure 7.2 Current California Ethanol Demand and Supply



Source: Schremp, Gordon. "Ethanol in California Security of Supply." California Energy Commission, Fuel and Transportation Division. January 10, 2007.

This would still leave California in an ethanol deficit, even at 2006 blend levels. Given that demand for ethanol is expected to increase by at least 60 million gallons by 2020 at the current 5.7 percent blends, or to double in the case of 10 percent blends in the same time period, it appears that California will have difficulty filling its tanks with ethanol made in the sunshine state, under current production scenarios. Currently, 80 percent of U.S. ethanol is produced in the Midwest, and the trend continues, as evidenced in Figure 7.3.

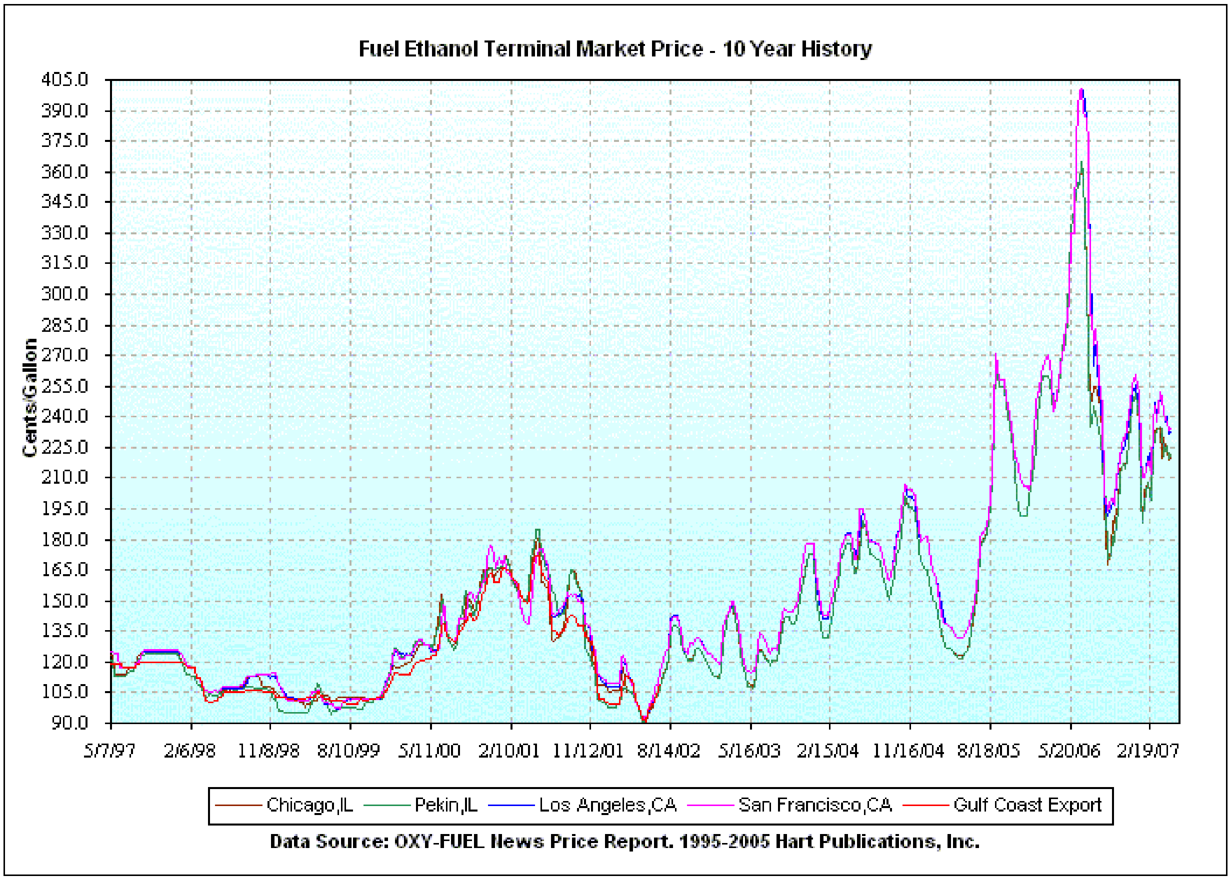
Figure 7.3 Ethanol Production Capacities by State



Sourced from Agricultural Marketing Service, USDA Ethanol Transportation Backgrounder, September 2007.

Some of the enthusiasm for ethanol in the Midwest is starting to dampen as profits are squeezed in the industry. Figure 7.4 shows the 10-year history of the fuel ethanol prices. The run-up on ethanol prices in 2005-2006 was partially due to increased demand from the newly passed Energy Policy Act that called for the first Renewable Fuels Standard for ethanol to 7.5 billion gallons. Meanwhile corn prices were less than $2 per bushel in 2005, and today are in the $3.70 range. The cost of feedstock is typically more than half of the operating costs of an ethanol plant, so ethanol is very sensitive to fluctuations in corn prices.

Figure 7.4. Terminal Market Prices for Ethanol, 1997 – 2007.



Sourced from: California Energy Commission, available at http://www.energy.ca.gov/ethanol/index.html

Can California grow its own ethanol?

Given current cropping scenarios, what is the potential for California-grown ethanol production? Crops that are raised in California that are suitable for conventional ethanol production are barley, corn, oats, rice sorghum, sugar beets and wheat. In 2006, these crops accounted for over 1.5 million acres, which is about 17% of all irrigated acres in California. [5]

[5] USDA National Agricultural Statistics Service, www.nass.usda.gov.

This analysis follows Williams, Jenkins and Gildart, updated with 2006 data and converted to U.S. measurements.[6] In crops that are grown for both grain and silage (primarily corn and sorghum) the total acreage was used, and the per-acre grain yield was used to calculate ethanol capacity. The results are reported in Table7.2.

Table7.2. 2006 California starch and sugar crops and ethanol potential

Commodity	Harvested Acres (thousand)	Yield/acre	Yield(units)	Ethanol Yield* (gal/acre)	Ethanol Potential (gal)
Barley All	65	55	bushel	77.0	5,005,000
Corn (All)	515	165	bushel	455.4	234,531,000
Oats	20	86	bushel	80.0	1,599,600
Rice All	523	7660	pounds	339.3	177,473,774
Sugar beets	43.1	36.1	tons	895.3	38,586,568
Sorghum (All)	32	105	bushel	283.5	9,072,000
Wheat All	315	66.5	bushel	186.2	58,653,000
Totals	**1513.1**				**524,920,942**

*Sources for conversion rates are USDA and Dale, B.E., Ethanol Production from Cereal Grains, Handbook of Cereal Science. 1991. p. 863-870.

If all of the current feed grain and starch crops listed above were to be used solely for ethanol production, the state would still be short approximately 426 million gallons of ethanol. If one adds in the 124 million gallons already being produced in state from various by-products and imported corn, California would reach approximately 625 million gallons of in-state produced ethanol, or about 65% of current demand.

This scenario is obviously unrealistic for a number of reasons. To grow in-state even 20% of ethanol, as set forth by the Governor's office by 2010, would require nearly the entire corn crop, which could produce 234 million gallons of ethanol in 2006. With the level of increased demand for ethanol, as well as the competing uses for high-value, specialty crops for the land and water needed for energy crop production, not to mention the feed demands of the dairy industry, it seems unlikely that a large portion of the corn crop could be devoted to ethanol production.

Cellulosic Ethanol Potential

Because of food/fuel tradeoff evident in corn-based ethanol, producing ethanol from other forms of biomass has captured the attention of researchers and policymakers. In order to meet the demand for ethanol in the coming years, significant resources have been

[6] Williams, R.D, Jenkins, B.M & Gildart, M.C. "California Biofuel Goals and Production Potential. Presented at 15th European Biomass Conference & Exhibition, 7 – 11 May 2007, Berlin, Germany. Available at www.ucdavis.edu/biomass.

invested in the development of ethanol from cellulosic biomass. Conventional ethanol and cellulosic ethanol are the same product, but are produced using different feedstocks and processes. Cellulosic conversion would use agricultural plant wastes (cereal straws, corn stover, sugarcane bagasse), plant wastes from industrial processes (sawdust, paper pulp) and energy crops grown specifically for fuel production, such as switchgrass. Cellulosic ethanol offers several advantages over conventional ethanol. These include potentially higher per-acre ethanol yields and lower input costs for dedicated energy crops, the recycling potential for agricultural and other biomass waste streams, and ability to use marginal lands and reduce the competition between food and fuel uses of crops. However, unlocking the sugars from cellulose is a much more difficult and expensive process than occurs in starch-based crops.

As a number of researchers have noted, the U.S. will be unable to grow enough biofuels feedstock from corn or other starch and sugar-based sources to substantially reduce reliance on imported petroleum or to reduce GHG emissions.[7] According to the Energy Information Administration, currently no commercial cellulosic ethanol production facilities are operating or under construction in the U.S. Financial incentives are provided in the Energy Policy Act of 2005 and strengthened in pending federal legislation. These incentives are designed to bring the first cellulosic ethanol production facilities on line by 2015, with a total capacity of 250 million gallons per year.[8]

A small plant in Ottawa, Canada, owned by Iogen Corp, produces 260,000 gallons of ethanol per year from 3,200 tons of wheat straw and corn stalks. The company is now working on a $300 million plant to produce 50 million gallons that could come online in 2008.[9] Other studies have predicted lower costs; a 2002 study by the National Renewable Energy Laboratory estimated total capital costs for a 69.3 million gallon cellulosic ethanol plant to be $200 million.[10] However, the costs are considerably higher for cellulosic conversion; a similar-sized corn-based plant would cost $67 million. Figure 7.5 shows the costs per barrel of various biofuels feedstocks, including new potential feedstocks such as jatropha, a perennial plant in the same genus as cactus which grows in Africa and is under research for its biofuels possibilities. Cellulosic ethanol is still at a cost disadvantage compared to all other currently available feedstocks.

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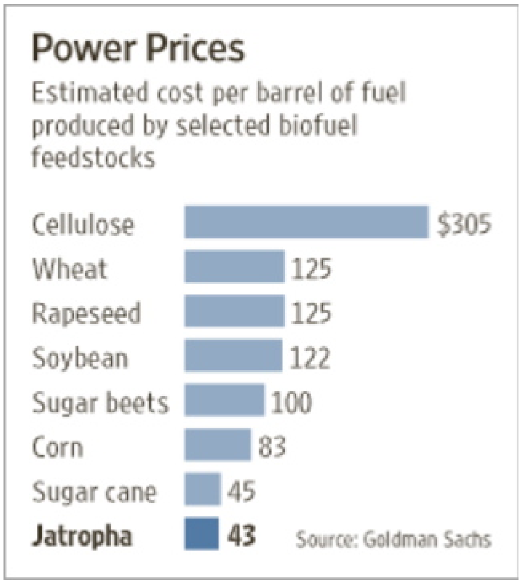
[7] Runge, C.F. and Senaur. B. "How Biofuels Could Starve the Poor." Foreign Affairs, May/June 2007.

[8] EIA. Biofuels in the U.S. Transportation Sector. February 2007. Available from: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

[9] Port, 0. "Not Your Father's Ethanol," *Business Week* (February 21, 2005), web site www.businessweek.com/ magazine/content/05_08/b3921117.htm.

[10] National Renewable Energy Laboratory, Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover, NREL/ TP-510-32438 (Golden, CO, June 2002), web site www. nrel.gov/docs/fy02osti/32438.pdf.

Figure 7.5 Price comparisons of biofuels feedstocks



Source: *Biofuels: Higher Prices & Trade Angles, However, Exports and Doha Still Important Considerations for U.S. Farmers,* graph originally published in *The Wall Street Journal* on August 24, Available at: www.farmpolicy.com/?p=459

A range of estimates of cellulosic ethanol potential in California from agricultural sources is provided in Table 7.3. This analysis follows Williams, Jenkins and Gildart, though this estimate deletes non-agricultural biomass sources from consideration.

Table7.3. California Cellulosic Biomass from Agriculture Potential, 2005*

	Technical Availability Million dry tons/year	**Ethanol Production Potential (Million gallons)**
Total Orchard and Vine	1.8	125
Total Field and Seed	2.4	160
Total from Ag Product Cellulose	4.2	285
1,320,000 acres Dedicated Cellulosic Energy Crop		
Assume Low Yield: 5 dry tons /acre	6.6	599
Assume High Yield 8.9 dry tons/acre	11.7	1350

*Assumes a conservative yield of 70 gallon per ton for field and seed crops, orchard and vine prunings.

Source: Williams, R.D, Jenkins, B.M & Gildart, M.C. (2007) Ethanol Production Potential and Costs from Lignocellulosic Resources in California.

Table 7.3 indicates that between 884 and 1,635 million gallons of ethanol could be produced from agricultural sources cellulosic biomass, if a dedicated energy crop is included. One should note that forestry byproducts were left out of this analysis; their inclusion would have increased the yield of cellulosic waste biomass by about 70%. Should the cost of cellulosic ethanol production decline, and available land resources found to grow the dedicated energy crop, this may hold promise for meeting the state's renewable fuel production goals by 2050, under the high yield scenario.

It is important to note that the same data was used to calculate agricultural waste biomass' contribution to ethanol production as was used to estimate the electrical generation potential from biomass. Using this level of biomass for ethanol will obviously eliminate it from the electricity production, so a new trade-off presents itself among competing uses for energy production from biomass.

Barriers to increased Production of Ethanol for Transportation Fuel in California

Barriers to increased ethanol production in California primarily fall under adequate feedstocks, infrastructure and price uncertainty, some of which are the same for biomass conversion to electricity. As the industry continues its explosive rate of growth, the following issues may occur:

Infrastructure and Supply Chain[11]

- Concern about the adequacy of the transportation infrastructure to efficiently ship corn, ethanol and co-products from Midwest production centers to coastal demand centers
- Capacity of rail, barge and truck modes of transportation are already at or near maximum
- Virtually non-existent retail infrastructure for E85 filling stations in California
- Potential bottlenecks at numerous points along supply chain
- Inability of ethanol to be transported via existing fuel pipelines

Feedstock

- High competition for current corn feedstock with dairy and livestock industry in California
- Fluctuations in feedstock costs have enormous impact on ethanol profitability
- Corn-based ethanol requires heavy water use in growing feedstock as well as converting feed to ethanol
- Lack of cost-effective, commercial-scale alternatives to corn ethanol
- Availability of corn for new California ethanol plants as Midwest ethanol production expands – under current expansion plans, several Midwestern states may become corn deficient.

[11] Agricultural Marketing Service, USDA. Ethanol Transportation Backgrounder. Sept. 2007. Available at: http://www.ams.usda.gov/tmd/TSB/EthanolTransportationBackgrounder09-17-07.pdf

- Opportunity cost of growing corn on acreage that can produce high-value, specialty crops in California
- Currently no commercially viable method to produce ethanol from cellulosic sources

Prices

- Predicted glut of ethanol may depress prices. Ethanol prices declined 30% from May to September 2007, with further decreases predicted as additional ethanol plants come online
- Ethanol price is tied to both feedstock prices and oil prices, both of which fluctuate widely and affect profitability
- Uncertainty about continuity of ethanol import tax
- Possible consumer backlash regarding corn ethanol’s impact on food prices

Public perception

- Many flex-fuel vehicle owners are unaware that their cars can run on E85
- Lack of understanding of ethanol as part of the fuel supply
- Lack of understanding of challenges of bringing cellulosic ethanol to market, “silver bullet” mentality.

Chapter 8 - Biodiesel

Though biodiesel is considered by many consumers to be a new technology, Rudolph Diesel, inventor of the diesel engine, produced an engine in 1897 that could run on vegetable oil.[1] However in the early 1900s, the petroleum industry introduced petroleum-based diesel, and only recently has the industry returned to renewable forms of diesel fuel.

Biodiesel is composed of mono-alkyl esters of long-chain fatty acids derived from vegetable oils or animal fats.[2] Biodiesel can be blended with petroleum diesel in any percentage and used in diesel engines, so long as the fuel system that uses it is constructed of materials that are compatible with the blend. Common blends of biodiesel are 2 percent, 5 percent, and 20 percent (B2, B5, and B20). Most diesel vehicles will run on a B5 blend, and many manufacturers support B20 without a void in the warranty.[3]

California biodiesel demand

Currently over 4 million gallons of biodiesel is used annually in California, out of a total of 3 billion gallons of conventional diesel, or 1.3 percent of total diesel consumption.[4] With recent legislation promoting the use of bio-based fuels, as well as the increased availability at filling stations, the demand for biodiesel is expected to rise dramatically, to a minimum three-fold increase at the lowest blend level by 2010. A recent study estimated the demand potential for in-state biodiesel, based on current legislative and executive branch production goals discussed in previous sections.

Table 8.1 Projected in-state biodiesel demand (million gal/year)

Year	B2	B5	B20
2010	13	31.2	127.4
2020	33.8	85.8	338
2050	145.6	366.6	1469

Source: Williams, R.D, Jenkins, B.M & Gildart, M.C. "California Biofuel Goals and Production Potential. Presented at 15th European Biomass Conference & Exhibition, 7 – 11 May 2007, Berlin, Germany. Available at www.ucdavis.edu/biomass.

[1] Energy Information Administration, *Diesel Fuel Prices: What Consumers Should Know* May 24, 2007. http://www.eia.doe.gov/bookshelf/brochures/diesel/index.html

[2] National Biodiesel Board, "Biodiesel—Commonly Asked Questions," web site www.nbb.org/pdf_files/fuelfactsheets/CommonlyAsked.PDF.

[3] Energy Information Administration, Biofuels in the transportation sector, Feb. 2007. Available at: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

[4] California Energy Commission, Fuels and Transportation Division, updated Sept. 19, 2007. Available at: www.energy.ca.gov/transportation/index.html

California biodiesel production

Though much of U.S. production of biodiesel comes from soybean oil, soybeans do not grow well in California's climate. Safflower is the primary oil crop grown in California, but canola could also be a potential feedstock, and is popular in Europe for biodiesel production. Biodiesel also can be produced from a variety of other feedstocks, including vegetable oils, tallow and animal fats, and restaurant waste and trap grease. [5]

Currently, there are eight biodiesel plants operating in California, most of which are smaller scale, as reported in Table 8.2. Seven of these have opened within the past two years. Two of the newer plants have not reported their production capacity, but the total from the existing plants is at least 20 million gallons. A 60-million gallon plant is planned for the Port of Sacramento, to be on-line by 2009. It plans to source about 5% of its feedstock from area farmers.[6]

Table 8.2. Commercial Biodiesel Production Plants

Company	Location	Annual Production Capacity (gal)	Feedstock	Operating Since
Bay Biodiesel, LLC	San Jose	3,000,000	Soy	March 2007
Blue Sky Bio-Fuels, Inc.	Oakland	Not reported	Multi Feedstock*	January 2007
Central Valley Biofuels, LLC	Orange Cove	Not reported	Soy, Cottonseed	May 2007
Energy Alternative Solutions, Inc	Gonzales	4,000,000	Multi Feedstock*	December 2006
Evergreen Biodiesel	Big Oak Flat	50,000	Recycled Cooking Oil	July 2006
Imperial Western Products	Coachella	8,000,000	Multi Feedstock	October 2001
So Cal Biofuel	Anaheim	1,100,000	Yellow Grease, Virgin Oils	January 2007
Yokayo Biofuels, Inc.	Ukiah	250,000	Recycled Cooking Oil	April 2006

* Used to describe plants that can use a variety of feedstocks. In most cases, this means a plant is able to process vegetable oils, animal fats, recycled cooking oil or yellow grease.

Source: National Biodiesel Board, Commercial Biodiesel Production Plants, updated Sept. 7, 2007. Available at: http://www.biodiesel.org/buyingbiodiesel/producers_marketers/ProducersMap-Existing.pdf

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[5] Energy Information Administration, Biofuels in the transportation sector, Feb. 2007. Available at: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

[6] Downing, J. "Port OKs biofuel plant." Sacramento Bee, May 17, 2007. Available at: http://www.sacbee.com/103/story/182861.html

California biodiesel potential

Currently, very little of the oilcrop harvest grown in California is used to produce biodiesel. Safflower is the primary oilcrop grown in the state, though field trials are being conducted on canola. There is also some interest in using cottonseed oil as a feedstock to in-state biodiesel refineries, and it is already being used in one refinery, noted in Table 8.2.

In 2006, 56,000 acres of safflower were planted and harvested in California. The conversion rate for oilcrops is about 100 gallons of biodiesel produced per acre, so the current potential for biodiesel production from California grown oil crops is 560 million gallons, if every acre of safflower planted was processed into biodiesel.

In terms of cottonseed, the oil yield per acre is 17.1 gal/acre.[7] Cotton, with 557,000 acres harvested in 2006, would yield a total of nearly 9.5 million gallons. As most of the cottonseed is milled into livestock feed, this creates competition for feedstocks. Thus the current total available feedstock supply from oil crops grown in California is just under 570 million gallons.

A recent study estimated the acreage of oilseeds required to meet in-state production goals set forth through 2050 for the variety of biodiesel blends. These figures are reported in Table 8.3.

Table 8.3 Oil seed crop acreage requirements to meet state biodiesel production goals by blend levels

Year	B2	B5	B20
2010	130,963	323,701	1,294,804
2020	343,469	857,437	3,427,277
2050	1,487,542	3,718,855	14,875,420

Source: Williams, R.D, Jenkins, B.M & Gildart, M.C. "California Biofuel Goals and Production Potential. Presented at 15th European Biomass Conference & Exhibition, 7 – 11 May 2007, Berlin, Germany. Available at www.ucdavis.edu/biomass

In order to meet the production goals for biodiesel at the lowest blend rate, the number of acres committed to oilcrops would need to more than double by 2010. If in-state production goals are to be met at the highest blend rate by 2050, the acreage requirements are equal to half of the current agricultural acreage in California. Similar issues arise with respect to production of starch-based ethanol in California – what will the trade-offs be if these policies are to be fully implemented?

[7] Duke, J. A. (2001). Handbook of Nuts. Boca Raton, CRC Press LLC.

***Barriers to Increased Production of Biodiesel in California*[8]**

Biodiesel is subject to many of the same infrastructure and price barriers as ethanol, but because of the lower overall demand for diesel as compared to gasoline. Soybean prices have climbed at similar rates to those of corn, but it has a larger impact as feedstocks comprise about 70 percent of the operating costs of a biodiesel plant. It remains to be seen if safflower and canola prices will experience a similar increase if California ramps up biodiesel using those crops as feedstocks.

Co-products of biodiesel are also a potential barrier to increased production. Glycerin is a co-product of oilseed biodiesel production, and there is an oversupply of glycerin in the U.S. at this point. This is hampering biodiesel profitability as the price of glycerin has dropped over the past two years as biodiesel production has expanded.

Policies to Support Biodiesel

The state and federal policies supporting biodiesel production and consumption are discussed in Chapter 6.

[8] A further discussion of these barriers is found in the Energy Information Administration's *Biofuels in the transportation sector*, Feb. 2007. Available at: http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

Chapter 9 - Summary and Conclusions

This study intended to document the current demand for renewable electricity and renewable fuels in California, and to estimate the current and future contribution of renewable energy sourced from California agriculture. An overview of current relevant state and federal policies that encourage renewable energy production and consumption is provided. A summary of the findings are as follows:

Renewable Electricity:

Solar Power: Most of the 28 million acres devoted to California agriculture are in areas with good-to-excellent solar power potential, based on solar resource maps. Despite the fact that the Go Solar Initiative (GSI) can fund up to half the cost of a solar installation, and net metering provisions can greatly reduce electricity costs for farms and agribusinesses in the long run, it seems that very few agricultural businesses are taking advantage of these programs. A conservative estimate for solar installations scaled appropriately to farm size indicates that over 1,300 MW could be gained toward the GSI's 3,000 MW installation goal by 2017. Currently, solar energy provides barely 400 MW of the state's energy resources, or less than .05%. The projections here conclude that solar power from agriculture could contribute an additional 5% of the state's electricity needs.

Wind: Wind energy currently contributes about 2% of California's electricity. Wind energy is much more geographically specific than is solar energy, so it may have more limited applications in California agriculture. Even so, there are many opportunities for California farms in the wind resource areas to take advantage of generous rebate programs and net metering for small wind systems. The rebates are similar to those in solar, and can offset half of the cost of a wind system. Because the current policy scenario does not favor farmer-owned, commercial-scale wind systems (as is possible in other states), small wind systems to save long-term energy costs and to reduce demand on the grid are the best option for California agribusiness.

Agricultural Waste Biomass: Current agricultural biomass contributes 173.6 MW of online energy capacity to California, which is 0.18% of the total MW capacity of all power plants in California. The net technical potential for agricultural waste biomass is 880 MW. That 880 MW would produce an additional 6,554 GWh in electrical energy or 2% of California's electricity needs, which is double the current amount of biomass electricity generated from all sources in California. Agricultural waste biomass can play an important role in meeting the state goals for biomass energy use. Programs such as the Dairy Power Production Program and net metering for biogas encourage development of biomass plants, however, net metering is limited to 50 MW for biogas generation, which appears to be low, given the potential of 880 MW from biogas in the state.

Renewable Fuels:

Ethanol: California is the nation's largest consumer of ethanol at 951 million gallons, but produces just over 10 percent of its current ethanol needs. State renewable fuel production goals and the federal Renewable Fuels Standards may double the ethanol needed in the state by 2020, depending on fuel blend percentages, to approximately 2 billion gallons. In-state ethanol is produced primarily from imported Midwest corn. It is unlikely that California will meet its ethanol production needs from corn and starch crops grown in the state; even if every acre of land currently committed to those crops was used for ethanol production, it would produce less than half of the current ethanol demand. Moving additional crop acres into these crops is unlikely, as the competition for land resources in a high-value, specialty crop state is already intense. Cellulosic ethanol, should it ever become commercially viable, may provide a solution to meeting in-state ethanol production goals. An estimate that included both agricultural biomass wastes as well as 1.3 million acres of a dedicated cellulosic ethanol crop showed a range of ethanol production of 884 – 1,635 million gallons of production potential. Federal research goals call for developing a commercially viable cellulosic technology by 2015.

Biodiesel: In order to meet the state production goals for biodiesel at the lowest blend rate, the number of acres committed to oilcrops would need to more than double by 2010, from 56,000 grown in 2006 to more than 130,000. Soybeans, the predominant feedstock for biodiesel in the U.S., are not suitable for California's climate. Safflower is the current oilcrop that could be used for biodiesel production, and research is being conducted on canola. If in-state production goals are to be met at the highest blend rate by 2050, the acreage requirements are equal to half of the current agricultural acreage in California, or about 14 million acres.

In summary, it seems more likely for California to increase its development of agricultural sources of electricity in the near future than it will be to move into large-scale biofuels production. Proven technology and generous policies are already in place for California farms, ranches and agribusinesses to take advantage of solar, wind and biomass electricity resources. There are literally millions of dollars available each year in rebate and grant programs to implement solar, wind and biomass projects that California agricultural industry leaves on the table. Most of these projects would be considered distributed energy projects, and would decrease energy costs over the long term, reduce demand on the electric grid, and reduce California's reliance on imported electricity. Producing electricity from renewable sources on farms, ranches and agribusinesses is a complementary, not competitive, activity.

Though biofuels seem to have captured the attention of policymakers and the public at large to a much greater extent than renewable electricity, the opportunity costs are quite high for California to develop its own base of biofuels using current production technology. Steep competition for the considerable land and water resources needed for ethanol production and the enormous impact on dairy and other livestock sectors as feedstocks are converted to fuel cannot be ignored. Biodiesel has the same issues, but to a lesser extent, as neither the fuel nor the feedstock is in as high demand in California. Cellulosic ethanol, which is not currently commercially available, may hold some promise without the food/feed issues associated with starch-based ethanol. However, land resources will still be needed, and competition for those resources will remain, and infrastructure needed to support cellulosic ethanol products is as yet unknown.

References

Agricultural Marketing Service, USDA. *Ethanol Transportation Backgrounder*. http://www.ams.usda.gov/tmd/TSB/EthanolTransportationBackgrounder09-17-07.pdf Sept. 2007.

American Coalition for Ethanol. "STATUS '07: A State By State Handbook." http://www.ethanol.org/pdf/contentmgmt/ACE120_Status_07_web-1.pdf

American Wind Energy Association. California Wind Projects. http://www.awea.org/projects/california.html Updated June 30, 2007.

American Wind Energy Association, U.S. Wind Energy Project Map. http://www.awea.org/projects/. September 2007.

California Energy Commission. *Biomass in California: Challenges, Opportunities, and Potential for Sustainable Management and Development*, California Energy Commission report CEC-500-2005-160, June 2005.

California Energy Commission, *California Gross System Electrical Production* http://www.energy.ca.gov/electricity/gross_system_power.html

California Energy Commission *California Solar Resources*, April 2005, CEC-500-2005-072D.

California Energy Commission, Fuels and Transportation Division. www.energy.ca.gov/transportation/index.html Updated Sept. 19, 2007.

California Energy Commission, Public Interest Energy Research. "Overview of Biomass to Ethanol." http://www.energy.ca.gov/pier/renewable/biomass/ethanol/index.html

California Energy Commission *2007 California Power Plant Database* www.energy.ca.gov/database/index.html#powerplants

California Energy Commission, *California Wind Resources* Draft Staff Paper, CEC-500-2005-071D. April 2005.

California Energy Commission, Emerging Renewables Program Account Activity http://www.energy.ca.gov/renewables/emerging_renewables/index.html

California Energy Commission, *Transportation Energy Forecasts for the 2007 Integrated Energy Policy Report*. CEC-600-2007-SD. July 2007.

California Global Warming Solutions Act, AB 32, Nunez and Pavely, Statues of 2006.

California Public Utilities Commission. PUC REMOVES MANDATORY TIME-OF-USE RATES FOR SOLAR CUSTOMERS, News Release June 7, 2007. Available at: http://www.gosolarcalifornia.ca.gov/news/2007-06-07_CPUC_NEWS_RELEASE.PDF

California Solar Initiative. Available at: www.gosolarcalifornia.org

Database of State Incentives for Renewable Energy, updated Sept. 12, 2007. Available: www.dsireusa.org

Downing, J. "Port OKs biofuel plant." *Sacramento Bee*, May 17, 2007. Available at: http://www.sacbee.com/103/story/182861.html

Duke, J. A. (2001). Handbook of Nuts. Boca Raton, CRC Press LLC

Energy Information Administration, Biofuels in the transportation sector, Feb. 2007. http://www.eia.doe.gov/oiaf/analysispaper/biomass.html

Energy Information Administration, *Diesel Fuel Prices: What Consumers Should Know* May 24. 2007. http://www.eia.doe.gov/bookshelf/brochures/diesel/index.html

Energy Information Administration, Electricity Consumption by End Use in U.S. Households, 2001. http://www.eia.doe.gov/emeu/reps/enduse/er01_us_tab1.html

Greer, Diane. "Creating Cellulosic Ethanol: Spinning Straw into Fuel." BioCycle eNews Bulletin. April 2005. http://www.harvestcleanenergy.org/enews/enews_0505/enews_0505_Cellulosic_Ethanol.htm

Lee, C. California farmer plugs into solar in a big, big way. *California Country Magazine*, California Farm Bureau Federation. September/October 2005. Available at: http://www.cfbf.com/magazine

Lifsher, M. "Rebate rules chill sales of solar." *Los Angeles Times*. May 28, 2007. p. C1.

Moller, R.M., *Brief on Biomass and Cellulosic Ethanol.*, California Research Bureau, California State Library, CRB 05-010, December 2005.

National Agriculture Statistics Service, USDA (2006), Available at http://www.nass.usda.gov/QuickStats

National Biodiesel Board, "Biodiesel—Commonly Asked Questions," Available at: www.nbb.org/pdf_files/ fuelfactsheets/CommonlyAsked.PDF.

National Renewable Energy Laboratory, Lignocellulosic Biomass to Ethanol Process Design and Economics Utilizing Co-Current Dilute Acid Prehydrolysis and Enzymatic Hydrolysis for Corn Stover, NREL/ TP-510-32438 (Golden, CO, June 2002), web site www. nrel.gov/docs/fy02osti/32438.pdf.

Parker, S. "Powered by Solar, Financed by Third-Party." Renewable Energy Access.com . January 4, 2007. http://www.renewableenergyaccess.com/rea/news/story?id=47009

Port, O. Port, "Not Your Father's Ethanol," *Business Week*, February 21, 2005. www.businessweek.com/ magazine/content/05_08/b3921117.htm.

Renewable Fuels Association, Industry Statistics 2006 (cited in 2007). Available at: www.ethanolrfa.org

Renewable Fuels Association, Ethanol Facts: Trade. Available at: http://www.ethanolrfa.org/resource/facts/trade/

Rueters. "California nut growers use sun for power, too." May 22, 2007. Available at: http://www.reuters.com/article/environmentNews/idUSN2240797420070522?pageNumber=1

Runge, C.F. and B. Senaur. "How Biofuels Could Starve the Poor." *Foreign Affairs*, May/June 2007.

Schremp, Gordon. "Ethanol in California Security of Supply." California Energy Commission Fuel and Transportation Division. January 10, 2007. http://www.energy.ca.gov/2007publications/CEC-999-2007-006/CEC-999-2007-006.PDF

Schwarzenegger, Arnold. Executive Order S-3-05; Available from http://gov.ca.gov/index.php?/executive-order/1861

Schwarzenegger, Arnold. Executive Order S-06-06. 2006. Available from http://gov.ca.gov/index.php?/executive-order/183/

USDA Rural Development, 9006 Program recipients, various years. www.rurdev.usda.gov

Western United Development Co., Dairy Power Production Program. Available at: http://www.wurdco.com/DPPPbackgrounder.htm.

Williams, R.D, Jenkins, B.M & Gildart, M.C. "California Biofuel Goals and Production Potential." Presented at 15th European Biomass Conference & Exhibition, 7 – 11 May 2007, Berlin, Germany. www.ucdavis.edu/biomass.

Williams, R.D, Jenkins, B.M & Gildart, M.C "Ethanol Production Potential and Costs from Lignocellulosic Resources in California." Presented at 15th European Biomass Conference & Exhibition, 7 – 11 May 2007, Berlin, Germany. www.ucdavis.edu/biomass.