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Brief on Biomass and Cellulosic Ethanol

Rosa Maria Moller, Ph.D.

Prepared at the Request of Senator Richard Alarcón

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INTRODUCTION

This brief has been written at the request of Senator Richard Alarcón. Its objective is to provide information on (1) the availability of biomass, (2) potential for cellulosic ethanol production in California, and (3) federal and state policies that support the use of biomass, particularly for ethanol production. This document integrates information from the Biomass Collaborative publication referred as the White Paper, as well as from other reports on biomass and ethanol. This brief also includes information gathered through conversations with representatives of the ethanol industry and representatives from government agencies.

There are three sections in this document. Section I discusses the amount and composition of biomass available in California, biomass utilization and costs and benefits of using it. Section II evaluates the amount of biomass for cellulosic ethanol production in California and the main challenges faced by ethanol producers. Section III provides an overview of the most important federal and state policies that help biomass utilization and ethanol production.

SECTION I. BIOMASS IN CALIFORNIA

DEFINITION OF BIOMASS

Biomass (or cellulosic materials) is defined as matter produced through photosynthesis. It includes plant materials; agricultural, industrial, and municipal wastes, and residues derived from there (such as switch grass, rice straw, sugar cane (bagasse), trees, paper waste, plastics, plant and tree clippings cardboard). Biomass contains three primary constituents: cellulose, hemicellulose and lignin, and can contain other compounds (for example, extractives).

Cellulose and hemicellulose are carbohydrates that can be broken down by enzymes, acids, or other compounds to simple sugars, and then fermented to produce ethanol.

BIOMASS AVAILABILITY

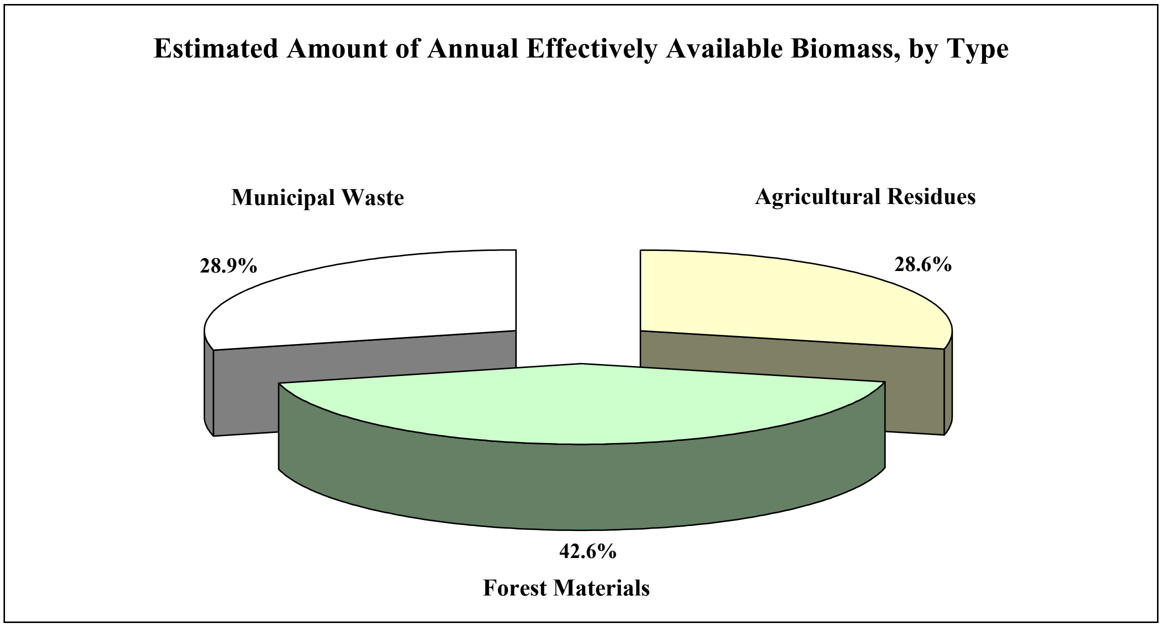
There is a large amount of biomass in California. The principal components of biomass are: agricultural residues, forest materials, and municipal waste. In addition, it is possible to grow crops to be used specifically as feedstock for energy or for the development of products derived from biomaterials. These crops are referred to as dedicated crops.

Nearly 90 million tons of biomass are produced annually in California, but only 30 to 40 million tons are estimated to be technically feasible to collect and use in producing renewable electricity, fuels, and biomass-based products. About 30 percent of this amount could come from agriculture, 40 percent from forestry, and another 30 percent could be recovered from municipal sources, including landfill gas and biogas (methane) from wastewater treatment. Table 1 provides detailed estimates of the annual availability of various types of biomass.

The amount of biomass that can be effectively utilized is lower than the total biomass that exists in the state for a number of reasons. Terrain limitations, environmental and ecosystem requirements, collection inefficiencies, inability to collect materials from remote or inaccessible areas, and a variety of technical and social constraints limit the amount of biomass that can actually be used for energy and biomass-based production. For example, some of agricultural crop or forest residues are needed to maintain soil fertility and tilth, or for erosion control. Chart 1 shows the distribution of effectively available biomass per year in California, by type of biomass.

By 2017, biomass from agriculture, forestry, municipal wastes, and dedicated crops could increase by 15 million tons, to approximately 100 million dry tons per year, and the effective amount of biomass that can be utilized could be more than 40 million dry tons per year. Two thirds of this growth comes from municipal solid and animal wastes and most of the rest will come from dedicated crops, since agricultural residues and forest materials are expected to remain at current levels.[1]

Chart 1



Agricultural Residues

California generates more than 20 million dry tons of agricultural residues per year. Half of this amount can be effectively used for energy and other biomass-based production. Although distributed throughout the state, the Central Valley has the highest concentration of agricultural biomass. Most of the agricultural residues fall in five categories:

1. Orchard and vineyard prunings and removals
2. Field and seed crop residues
3. Vegetable crop residues
4. Animal manure
5. Food processing wastes

Table 1 shows detailed estimates of annually available biomass derived from various types of agricultural residues.

About one million tons of agricultural residues derived from orchard prunings and tree and vine removals are currently utilized as fuel in direct combustion power plants. There are effectively more than two million tons of field and seed crop residues (principally cereal straws and corn) that could be used for biofuel production. Field and seed crop residues are not currently used for power generation due to problems with ash slagging and fouling in combustion systems.[2]

Vegetable crop residues are not generally considered for off-field utilization and are commonly incorporated into the soil.

Table 1

Estimated Amount of Annually Available Biomass in California, 2005		
Units: Million Dry Tons/Year, Except as Noted	**Total Biomass Produced**	**Biomass That Can Effectively Be Utilized**
Total Biomass	***86.0***	***33.6***
Total Agricultural	***21.6***	***9.6***
Total Animal Manure	11.8	4.5
Total Cattle Manure	8.3	3.0
Milk Cow Manure	3.8	1.9
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
Total Forestry	***26.8***	***14.3***
Mill Residue	6.2	3.3
Forest Thinnings	7.7	4.1
Logging Slash	8.0	4.3
Chaparral	4.9	2.6
Total Municipal	***37.6***	***9.7***
Biosolids Landfilled	0.1	.(2)
Biosolids Diverted	0.6	0.5
Total MSW Biomass Landfilled	18.5	.(2)
Total MSW Biomass Diverted	18.4	9.2
Landfill gas	118 BCF/y (1)	79 BCF/y
Biogas from waste-water treatment plants (WWTP)	16 BCF/y(3)	11 BCF/y

Source: California Energy Commission (CEC). "Biomass in California: Challenges, Opportunities, and Potentials for Sustainable Management and Development." PIER Collaborative Report. California Biomass Collaborative. CEC: Sacramento, June 2005.

1) Total landfill gas potential is 118 billion cubic feet per year (BCF/y) for an assumed composition of 50% methane from waste already in place. Diversion of MSW shown as landfilled will reduce future landfill gas potential but may increase generating capacity through use of conversion technologies. Increased diversion would also support potential increases in biofuels.

(2) Assumed landfilled, resource available as landfill gas.

(3) Billion cubic feet per year of biogas (60% methane).

The agricultural animal population in the state is close to 280 million including 230 million broiler chickens. Total manure production from animals is close to 12 million tons per year, with eight million tons per year from cattle and nearly half of that from milking cows in dairies. The Dairy Power Production Program in California is currently supporting efforts to use manure from approximately 33,000 milk cows.*

Food processing operations in California produce a variety of biomass feedstocks 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. Cheese whey and waste sugars are currently used in ethanol production. California produces about eight million gallons of ethanol per year. In addition, at least 250,000 tons per year of food processing residues are used for power generation, mainly from rice hulls, shells, and pits.

Biomass From Forest Materials

There are 40 million acres of forest in the state with an average standing tree biomass of 71 tons/acre. Of the total acreage, 46 percent is national forest, 12 percent is other public forest, and 42 percent is private.[3] Non-marketable standing forest and shrub biomass† is currently estimated grossly at 1.3 billion BDT (bone dry tons).‡ Table 1 shows detailed estimates of forest biomass availability per year.

Forestry residues include:

1. Logging slash (branches, tops, and other materials removed from trees during timber harvest). Slash has declined with lower logging activity.

2. Forest thinnings such as understory brush and small diameter tree boles. Forest thinnings are intended to restore the health of forests and reduce fire risk. Operations to obtain thinnings must be carefully done to avoid potential damage to forest ecosystems.

3. Sawmill residues from mill and other manufacturing operations, such as bark, sawdust, shavings, and trim ends. About 1.3 million tons of these materials are used for power generation in California, as fuel to heat boilers in co-generating facilities.

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* The purpose of the Dairy Power Production Program (DPPP) is to encourage the development of biologically based electricity generation projects on California dairies. Their grant program is overseen by an advisory board comprised of representatives from the dairy industry; the Environmental Protection Agency; the California Energy Commission; Sustainable Conservation; the University of California; the California Department of Food and Agriculture; the State Water Resource Control Board, and the USDA's Natural Resource Conservation Service.

† Shrub or chaparral is comprised of mostly shrubby evergreen plants adapted to the semi-arid desert regions of California, especially in the south state. There has been little development of this biomass for energy. Shrub biomass has no current commercial value and it is only available through habitat improvement activities (such as thinning) or fuel treatment operations designed to reduce wildfire risks.

‡ Ton of material at nominal zero moisture content.

4. Shrub and chaparral. Mostly shrubby evergreen plants adapted to the semi-arid desert regions of California (mostly in Southern California). Because these plants provide habitat for wildlife, extensive shrub and chaparral removals have negative environmental effects.

Municipal Waste

Each Californian produces more than two tons of municipal wastes containing one dry ton of biomass per year. Municipal wastes include municipal solid wastes (MSW), municipal wastewater or sewage, and bio-solids from wastewater treatment. Landfill gas generated from waste disposed in landfills and biogas from wastewater treatment are also included in municipal waste.

The biomass component of MSW totals 38 million dry tons per year, ten of which could be effectively used. These materials include construction and demolition wood residue, paper and cardboard, grass, landscape tree removals, other green waste, food waste, and other organics.[4]

The 1989 Integrated Waste Management Act (AB 939) mandated that local jurisdictions divert at least 50 percent of generated wastes from landfills by 2000. The state is close to achieving that goal. Remaining wastes are disposed in landfills and three mass-burn incineration facilities. Diverted wastes are used for compost,[*] alternative daily cover (although this also contributes to landfill),[†] recycling, and energy. There are more than 3,000 waste disposal sites in the state, most of them now closed to further disposal but more than 230 are actively receiving waste. Total waste in-place exceeds 1 billion tons.[5]

The biomass portion of waste placed in landfills decomposes over time, resulting in the production of a methane-rich landfill gas that can be used for energy or chemical processing. The total landfill gas generation from more than 300 major landfills is estimated at between 118 and 156 billion cubic feet per year (BCF/y) for a methane concentration of 50 percent. Landfill gas is already used for heat and power generation as well as being upgraded to pipeline quality. Landfill gas is also being used as transportation fuel. The methane equivalent is 59 to 78 BCF/y. By comparison, natural gas consumption in the state is 2,200 BCF/y (see Table 1).[6]

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[*] Composting is the controlled decomposition of organic materials, such as leaves, grass, and food scraps, by microorganisms. The result of this decomposition process is compost, a crumbly, earthy-smelling, soil-like material. Composting can occur in the backyard, at a community site with yard trimmings, or in an industrial facility with mixed MSW. The resulting compost is a valuable product that can have many innovative uses. For example, compost can be used as a soil additive for backyard gardens and farmlands or to beautify highways and other landscaping projects.

[†] Alternative daily cover means cover material other than earthen material placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter, and scavenging. Waste derived materials that are approved by the Waste Management Board and can be reported as diversion include ash and cement kiln dust, treated auto shredder and construction and demolition waste, sludge, shredded tires, among others.

The total biogas resource from wastewater treatment is currently 16 BCF/y for a methane concentration of 60 percent, or 9.6 BCF/y methane equivalent.[7]

Dedicated Crops

Dedicated crops are crops especially cultivated and harvested for energy or biobased production. The most common dedicated crops are sugar and starch crops (including corn, sweet sorghum, sugar beets, and sugar cane). These crops can be used to produce biofuels (such as ethanol). Corn can be used in the manufacture of polylactic acid (PLA) to make renewable biomass-based polymers and plastics. Residues from these crops (corn stover or residue left after corn harvest, for example) provide additional biomass. Currently there are oil crops such as sunflower and safflower grown on recycled drainage water for biodiesel production.

Marine and freshwater aquatic species could also provide additional biomass. According to a report published by the California Biomass Collaborative, offshore production of giant kelp (*Macrocystis pyrifera*) was investigated for many years as a means of producing renewable methane (but has not been used commercially). Algae also have been widely investigated for photobiological hydrogen production.[8]

BIOMASS UTILIZATION FOR ENERGY GENERATION

Electricity Generation

Biomass feedstock is used for electricity generation. Existing and near-term planned biomass grid generating capacity in California in 2005 was 969 megawatts of electricity (MWe) (about two percent of statewide peak power capacity) including solid-fueled combustion power plants and engines, boilers, and turbines operating on landfill gas, sewage digester gas, and biogas from animal manures. There is enough biomass in the state to provide approximately 4,700 MWe, roughly 12 percent of current statewide electrical energy consumption. With improved conversion efficiencies and additional resources, annual biomass might support the generation of 7,100 (MWe) by 2017.[9]

Renewable Fuel Production

Renewable fuel production includes fuels such as ethanol, methanol, hydrogen, biodiesel, and Fischer-Tropsch liquids (fuels derived using the Fischer-Tropsch conversion process).[*] The Fischer-Tropsch (FT) process can produce diesel, naptha, and other fuels that can be used as substitutes for gasoline. Fischer Tropsch facilities for biomass are only at an experimental state. Syngas and biomethane can also be derived from biomass. Landfills produce a methane rich biogas that is most commonly used for power generation as discussed previously. Biogas can also be used as a transportation fuel, similar to compressed natural gas. Several European countries are already using it for

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[*] Fischer-Tropsch is a method where synthesis gas, a mixture of hydrogen and carbon monoxide, is reacted in the presence of an iron or cobalt catalyst producing products such a methane, synthetic gasoline, and alcohols.

this purpose. Carbon dioxide (CO_2), the other major gas in biogas besides methane, can be removed to yield an enriched biomethane fuel substituting for natural gas.

Biobased Product Development

Biomass can also provide raw materials for a diversity of biobased products. For example, plastics from biomass are being produced using polylactic acid from corn.

CONDITIONS FOR SUSTAINABLE USE OF BIOMASS

The effective use and maintenance of a sustained supply of biomass requires:

- <u>The continual renewal of biomass used</u>. Important aspects of sustainable resource management include: reforestation and replacement of nutrients for the cropping systems subject to biomass removal.

- <u>Continual evaluation and mitigation of agronomic and ecosystem impacts.</u> Extensive biomass removal has negative effects on the environment. For example, not all agricultural crop or forest management residue should be harvested where it is needed to maintain soil fertility and tilth, or for erosion control. Removal of forest materials could affect soils, carbon and nutrient cycles, forest productivity, biological diversity, wildlife and endangered species habitat, site hydrology, downstream flooding, stream siltation, water quality, and fisheries. Environmental impact assessments are necessary to determine site-specific impacts from biomass-based projects. Removals of forest materials must follow federal, state, and local rules.

- <u>Evaluation of net environmental effects and life cycle impacts of biomass collection and conversion</u>. A comparison of the environmental and life-cycle performance standards of various production processes is important to assess whether the economic and environmental costs of collecting and converting biomass into energy outweighs the benefits obtained from using that source of energy.

BENEFITS FROM BIOMASS UTILIZATION

Reduced Dependency on Imported Energy Sources

Biomass energy conversion processes that use less energy than they generate could significantly help reduce the use of fossil and imported fuels and the vulnerability of our economy to foreign disruptions in the energy markets.

Environmental Benefits

Compared to burning fossil fuel, there may be benefits associated with greenhouse gas reduction with the creation of markets for agricultural waste where its disposal has a negative effect on the environment. For example, the use of biomass as feedstock reduces net carbon emissions to the atmosphere and provides reductions in methane emissions from natural decay processes.

The ecologically responsible removal of slash from logged areas benefits the environment. For example, slash and small trees for energy conversion could be integrated with slash removals for the purposes of fire prevention and forest sanitation (disease and insect control).[*] By reducing the severity of forest damage from fires, insects, and disease, periodic removals of infected and combustible biomass will indirectly reduce erosion and combustion losses of organic matter and nutrients in the soil. Fire prevention reduces the potential of toxic emissions in the air.

There are also air quality benefits when agricultural residues such as rice straw are utilized rather than disposed through open burning. The use of other agricultural residues also reduces emissions of volatile organic compounds, odors, dust, and nuisances associated with agricultural operations such as dairies and animal feeding operations. Improved management of animal manure and solid wastes also reduces ground water contamination.

Economic Benefits

Biomass can be used for a wide range of bio-products, providing new market opportunities for agriculture. Potential benefits for California from this industry include new sources of income and jobs for the localities where biomass collection and conversion takes place. The integration of biomass crop production into more conventional agriculture may help in sustaining many rural and agricultural economies especially in the San Joaquin Valley. However, energy experts believe that for dedicated crops to become a substantial component of the biomass resource in the state it will take a concerted research and development effort and the state may need to provide incentives for biomass-based production.

According to energy experts, one of the best opportunities for near-term dedicated crop development is on land retired from agriculture in the San Joaquin Valley where more than 100,000 acres have now been retired due to shallow groundwater tables and salt buildup from inadequate drainage, and 1.5 million acres are considered drainage impaired.[10] Dedicated biomass crops could be used to help remediate these lands and provide economic relief to farmers and local communities. Dedicated crops would serve as biological pumps, lowering groundwater tables and reducing water logging of the soil. Waste heat from power generation could also be used to purify drainage water, recovering clean water and extracting salts.

There are economic gains from avoiding the economic and environmental costs and losses from wildfires and disposing of agricultural residues. Total annual economic loss

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[*] Ecologically responsible means activities are carried out to minimize environmental damage for soil, habitat, and ecology. To achieve this objective these activities should conform to California's Forest Practice Act and related rules, principles of ecological and water resources protection, and other environmental regulations.

from wildfires exceeds $160 million. The annual wildfire suppression cost exceeds $900 million.[11] Better use of biomass could probably reduce these costs significantly.

There are economic benefits from the biomass based industrial activities such as electricity generation, erosion control, and for the production of fuels, animal feed, and green or renewable chemicals (such as solvents and lubricants, polymers and plastics). Total economic benefits derived from these activities depend on the mixture of biomass-based products generated from it, as well as the state of maturity of these industries. For example, if 34 million tons of biomass per year were used to generate electricity, this operation would require a $14 billion investment and would create about 14,000 direct jobs (this figure does not include growth triggered by derived demand from this activity). In addition, this operation would displace about 13 million tons of carbon monoxide per year. In contrast, if the same quantity of biomass were used to manufacture cellulosic ethanol, 2.3 billion gallons of ethanol would be generated annually, with an investment of $8.5 billion and the creation of 3,600 direct jobs. Compared to gasoline, ethanol production would displace 18 million tons of carbon monoxide per year.[12]

COSTS ASSOCIATED WITH BIOMASS UTILIZATION

The collection and transportation costs of agricultural residues and forest materials for feedstock can be high. For example:

- The collection of some agricultural residues requires new cost-effective engineering systems because of their low bulk density and low tons/acre yield.
- The collection of agricultural residues may require using storage facilities and storage costs may be high. For example, agricultural residues left in the fields uncovered after harvesting can deteriorate due to accumulation of moisture and spontaneous combustion of feedstock. Therefore, to be able to use these residues it is necessary to protect them with tarps or store them in barns.
- In the case of rice-straw, practices developed for the harvesting and handling of grain may not be adequate for the harvesting and handling of straw.
- It is difficult to collect residues in wet fields.
- The lack of roadway infrastructure may increase the cost of or prevent collection of forest cellulosic materials and residue. Collection from some areas may require permitting and mitigation of adverse impacts, or may be prohibited.

Furthermore, it is difficult to collect a sustainable feedstock supply of consistent quality year-round because:

- Cellulosic-feedstock characteristics vary widely in terms of physical and chemical composition, size, shape, moisture content, and bulk densities. Some materials may be contaminated. For example, yard waste can be contaminated with dirt or rocks.

- Some materials such as agricultural residues may be available only on a seasonal basis.
- Materials may have low energy conversion yields. For example, when dealing with urban landfill waste, only about one third of it includes organic materials that could be used for energy conversion.

There are also environmental problems generated by biomass collection. The process of collecting agricultural waste may lead to excessive residual removal and losses in crop productivity, soil health, and carbon levels.

Silvicultural and timber harvest practices could have adverse effects on:

- Soils (could produce soil compaction, erosion, nutrient depletion). Soil compaction from harvesting and thinning machinery often decreases rain and snowmelt infiltration.
- Carbon and nutrient cycles.
- Forest productivity.
- Biological diversity, wildlife, and endangered species habitat. For example, biomass removal of organic matter reduces the leaf litter, twigs, and other nutrients on the forest floor available to decomposers such as invertebrates, beneficial insects, and fungi. These form the foundation of forest nutrient cycles and food chains that support local wildlife. Logs, snags, and living trees removals deprive habitat for wildlife and their prey. The removal of large quantities of algae to use as feedstock for energy conversion could harm marine habitat.
- Site hydrology, downstream flooding from increased surface runoff, stream siltation, water quality degradation, fisheries and aquatic habitat. For example, logging road cuts can intercept shallow subsurface ground water flows, thus acting as tributaries that increase the diversion to streams of overland, sheet-flow runoff that otherwise would infiltrate forest soils.

Since there are these potential problems associated with massive removal of biomass, environmental group representatives recommend caution in designing policies that support the expansion of biomass use. Some fear that the use of woody biomass as a renewable energy source could lead to overthinning, as demand for woody biomass exceeds the supply that is generated through responsible thinning (activities carried out taking into account environmental consequences for soil, habitat, and ecology). They also oppose incentives to create or reconstruct roads in the forests to facilitate inexpensive transportation of woody biomass since these actions could result in increased 1) erosion and sedimentation, 2) access to areas of the forest that previously had no roads, and 3) maintenance and enforcement costs for the federal agencies.

Some analysts argue that in certain cases it may be more costly to convert energy from biomass than using fossil fuels because the energy spent in harvesting, transporting, and processing woody biomass exceeds the energy produced by it. However, others point out that even in the case where there is net energy loss, there are significant benefits from using biomass rather than piling it in landfills or leaving it in the forest (where in some locations it would continue to pose a significant fire risk).

Environmentalists also question the use of methane digesters that use manure to generate electricity. Methane digesters are anaerobic (low or no oxygen) chambers which breakdown manure by anaerobic bacteria to release methane and other gases used to heat the digester and generate electricity.[*]

[*] See Sierra Club position at http://motherlode.sierraclub.org/MethaneDigestersSIERRACLUBGUIDANCE.htm

SECTION II. USING BIOMASS TO PRODUCE CELLULOSIC ETHANOL IN CALIFORNIA

Energy experts point out that the future of ethanol production in California depends on using waste and agricultural residues as feedstock rather than corn, a more expensive feedstock.* Ethanol from cellulosic biomass such as straw and other agricultural crop residues, the biomass fraction of solid waste, and potentially wood, may achieve substantially better net energy gains and lower cost, with a much larger resource base available compared to sugar and starch crops.

AVAILABLE BIOMASS FOR CELLULOSIC ETHANOL PRODUCTION

Taking into account that some biomass is either devoted to alternative uses (for example, used as feedstock for biomass power plants) or difficult and costly to collect,† a paper by the Biomass Collaborative estimates that there is enough biomass to support a production level of 1.5 billion gallons of ethanol in California. Their estimates are built on the assumption of an average yield of 70 ethanol gallons per ton of biomass. The production of this amount of ethanol from corn would require three million acres, or more than a third of the total irrigated agricultural acres in the state, using 12 million acre-feet of water. This corn-based operation, however, would also produce an additional 10 to 15 million tons of residue biomass.[13]

Residual sugars, cheese whey, and other sources already support production of approximately eight to 10 million gallons per year of fuel ethanol in the state, and development plans exist for much larger sugar- and starch-crop based facilities.

DEDICATED CROPS UTILIZATION FOR ETHANOL PRODUCTION

The viability of an energy-crop based ethanol industry depends on the market value of that energy-crop in alternative uses and the degree to which agricultural land resources are utilized.[14] In California, planting crops for feedstock is generally uneconomical because:

1) The market prices of alternative products that could be planted in the same land are relatively high.
2) The irrigation requirements for cultivating some of these energy-crops (corn for example) are high.
3) Land costs are high; however, this could become less of a problem if 1) yields of energy crops increase, and 2) the demand for growing biomass is integrated with

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* We are using here biomass (plant matter) and cellulosic materials as interchangeable words. According to the report by the National Commission on Energy Policy (*Ending the Energy Stalemate. A Bipartisan Strategy to Meet America's Energy Challenges*) cellulosic materials and renewable waste resources, are most highly concentrated in California, Minnesota, Illinois, Iowa, Texas, and Indiana.

† For example, biomass removals as part of forest fire prevention are difficult in areas that do not have road access. Other areas require permitting and mitigation of adverse impacts from forest material collections.

the demand for current agricultural products, so that farmers could sell different parts of the same plant to different markets.

The California Department of Food and Agriculture conducted a series of field demonstrations and laboratory studies to identify a variety of potential energy crops, taking into account land, irrigation, costs, and market prices.[15] Among these potential energy crops are: sweet sorghum, kenaf, Jerusalem artichoke, industrial sugar beets, and tree crops such as eucalyptus. Assuming that energy crops would occupy one million acres of the state agricultural land, production of ethanol based on energy-crops in California could generate around 500 million gallons of ethanol per year.[16]

CHALLENGES FACED BY CELLULOSIC ETHANOL PRODUCERS

The California ethanol industry based on cellulosic feedstock faces considerable challenges:

Feedstock-Price and Supply Variability

A steady and continuous supply of biomass feedstock is necessary to avoid feedstock variability risks. This is not a problem as long as the amount of biomass is sufficiently large compared to the ethanol industry. However, as other biomass-based industries start to develop, the price of cellulosic feedstock may increase significantly in some regions for cellulosic ethanol producers.

Among agricultural residues, rice straw is an attractive source of ethanol feedstock in California. Currently, farmers have three alternatives to dispose of rice straw: 1) burn a part of it (due to air quality concerns rice farmers have been required to burn increasingly less of their rice straw), 2) till it back into the soil, and 3) bale it and sell it for uses such as animal feed, bedding, erosion control, building products, and ethanol production. The ethanol industry may be able to use a significant amount of rice straw as feedstock as long as they could pay rice farmers enough for the rice straw to make cutting and baling costs competitive with plowing the straw back into the soil.[17] However, collecting these materials can be problematic because the practices developed for the harvesting and handling of grain may not be adequate for the harvesting and handling of straw.

The location of the plant near feedstock sources or the establishment of long-term contracts for feedstock may help to avoid fluctuations in the price and availability of cellulosic materials.

High Production Costs

The cost of processing cellulosic materials to produce ethanol is high. The development of new technologies has significantly decreased the cost of producing ethanol, particularly corn-derived ethanol. However, for some, technologies for cellulosic ethanol production are currently in the experimental state, while others believe that these technologies are already sufficiently mature but have not been widely applied due to lack of capital, which is difficult to attract for the implementation of new technologies.

There are a variety of technological problems for processing cellulosic materials that increase costs. One is that technologies designed to treat some feedstock are not adequate for other types of feedstock. For example, technologies used to treat cellulosic feedstock may not be appropriate for processing cull fruits due to the fundamental differences in the composition of these materials. There are also problems with the composition and potential contamination of feedstock. For example, papers may contain inks that would make them difficult to pre-treat and convert to ethanol.

Generally, existing cellulosic-to-ethanol conversion technologies have not yet been well demonstrated or widely applied commercially. However, some significant advances have been made in this direction:

- The company Iogen has patented a cellulose ethanol process called EcoEthanol.™ The process uses an enzyme hydrolysis to convert the cellulose in agriculture residues into sugars.[*] These sugars are fermented and distilled into ethanol fuel using conventional ethanol distillation technology. In April 2004, Iogen Corp. began selling the world's first commercial cellulosic ethanol.[18] Iogen is considering licensing their technology. With this process Iogen costs are expected to decrease from $1.30 an ethanol gallon to less than $1 a gallon.
- New innovations have reduced the cost of producing cellulosic ethanol. For example, Novozymes, a Davis biotech firm, recently found a way to drastically cut the cost of enzymes needed to create ethanol from rice straw and other agricultural waste. Their innovation brought about a 30-fold reduction in the cost of using enzymes.[19] Assuming the cost of enzymes is about 10 percent of total production costs, this would represent more than 9.5 percent total cost reduction in cellulosic ethanol production.[†]
- Other examples are Arkenol and BC International. In Japan, Arkenol is applying its own technology that allows ethanol production from woodwaste. BC International has also developed a technology that facilitates the fermentation of cellulosic materials. BC International has a plant in Louisiana, producing ethanol from sugar cane. These firms claim that they can expand their operations as soon as the financial resources are made available. However, according to some energy experts, these operations are still pilot projects, rather than commercial operations.[20]

[*] Iogen Corporation obtained the first (and non-exclusive license) from the Purdue Research Foundation for a genetically modified yeast that can produce ethanol from agricultural waste. Unlike traditional ethanol feedstocks, the cellulosic materials contain two major sugars, which cannot both be fermented into ethanol by common Saccharomyces yeast, the microorganism used by industry to produce ethanol from corn. The Purdue researchers altered the genetic structure of the yeast so that it now contains three additional genes that make it possible to simultaneously convert both sugars to ethanol.

[†] Based on costs reported in documents published by the Aspen National Renewable Energy Laboratory.

Risks Associated With Price and Market Demand Variability Driven by Government Policies

The availability of a significant market is important for the development of any industry. Government policies have significantly supported the demand for ethanol. Until recently, the oxygenate requirements (the addition of oxygenates to gasoline to enhance air quality, established under the Clean Air Act) have assured a significant level of ethanol use in California: an annual demand of nearly one billion gallons. The recent passage of the Energy Policy Act of 2005 established renewable standards, requiring the use of specified amounts of renewable fuels by refiners, but ended the oxygenate requirements. The effect of this change is still to be assessed.

The current trends in oil prices benefit the ethanol industry, but many predict that the policy changes will lower the demand for ethanol in California. If trends in oil markets reverse, ethanol demand may decrease even further, hurting the potential for a cellulosic ethanol industry to flourish in California.

Furthermore, all California ethanol producers have to compete with a mature Midwest ethanol industry based on corn, and with other countries, where production costs are lower. Competitors receive strong government support. Midwest states receive state support and a variety of incentives, in addition to the federal producers tax credit that helps the profitability of ethanol in the United States. California does not have any state policies geared to support the ethanol industry.[*]

Integration of Ethanol Production with Other Activities

To increase their profitability, California ethanol producers will have to look for innovative arrangements that allow the integration of various production processes and the access to feedstock sources.

Biorefinery Arrangement

The most profitable way to operate a biomass-to-ethanol plant is as a refinery producing a variety of products from processing all the chemical components (hemicelluloses, cellulose, lignin, and extractives) of cellulosic feedstock. The plant could make use of extractives by converting them to resin acids, or pharmaceuticals (taxols from specific conifers, for example). Cellulose derivatives can be processed into a variety of products including higher value animal feeds. The lignin fraction can be an energy source for the biorefinery or for an adjacent electric power plant.

One example is the integration of a power plant with biomass-to-ethanol facilities bringing about significant synergies that significantly decrease the cost of operation of both facilities. The biomass power plant can be a customer for the lignin produced by the

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[*] Policies that encourage the use of biomass and ethanol production are discussed in the next section of this report.

ethanol plant, using it as a fuel for the power plant, while the ethanol plant would benefit from cheaper steam and electricity.

Location Near Feedstock Sources

Plants located near feedstock sources will have lower transportation costs and sustained availability of feedstock. For example, it is convenient for an ethanol plant that uses landfill-diverted feedstock to locate near a material recovery facility. The plant can use the collection and processing infrastructure of the facility, which already collects, sorts, and distributes regional waste for various uses (including markets for recycled materials). There are benefits for the ethanol plant and the material recovery facility. The material recovery facility operator can benefit from reduced or avoided costs of disposing of the waste residuals used by the ethanol plant, and the ethanol plant will have much lower feedstock costs by just paying a fee rather than collecting and transporting feedstock from competing landfills.[21] A large transfer station/municipal recovery facility processes around 3,000 tons of total waste stream per day, supporting the necessary feedstock for a 10 million gallons per year ethanol plant.[22]

Other Integrated Process Arrangements

There are a variety of arrangements that can boost the economic viability of producing cellulosic ethanol. An example of a creative arrangement integrating various activities with ethanol production to take advantage of significant synergies is the Imperial Bioresources LLC project, in the Imperial Valley. The process begins with the cultivation of 20,000 acres of sugarcane that yields 1,200,000 tons of harvested cane annually. Cane will be processed into sugar, bagasse, molasses, ethanol, carbon dioxide, power, and cattle-feed. This project includes a cogeneration facility that burns bagasse and field trash for steam and electricity to meet the needs of the cane and beet processing plants with a surplus of power being available for the local grid. The beet-processing plant produces refined sugar and beet pulp (a desirable cattle feed material). Molasses generated from this plant can be diverted to the ethanol process. The cane processing will produce raw cane sugar, molasses, and bagasse. The molasses and any bagasse not required for the facility's energy needs are used as feedstock in the ethanol plant. The manufacturing of ethanol would produce carbon dioxide that can be used in the sugar clarification process or sold as industrial grade carbon dioxide. Instead of producing just beet pulp for cattle feed, the integrated plants will also deliver large quantities of bagasse and silage solids for animal feed blending, at a value set by available competing materials.

SECTION III: POLICIES SUPPORTING THE USE OF BIOMASS AND CELLULOSIC ETHANOL PRODUCTION

FEDERAL POLICIES ENCOURAGING BIOMASS UTILIZATION

The Biomass Research and Development Act of 2000

The Act set policy to develop a comprehensive national strategy stimulating the development and use of bioenergy and bioproducts through research, development, and private sector incentives. This Act established the Office of Biomass Programs, the Biomass Research and Development Technical Advisory Committee, and the Biomass Research and Development Initiative to promote bioenergy and bioproduct research, development, demonstration, and deployment. The federal vision published in 2002 established goals for 2010, 2020, and 2030. By 2030, the goal is to double the biomass share of electricity and heat used by utilities and industry, increase transportation biofuels by 65 times, and expand the share of bioproducts by five times over current levels.[23]

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 biobased products. In fiscal year 2004, the two departments awarded $25 million to 22 projects, and cost sharing by private sector partners raised the value of the projects to nearly $38 million. 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.[24]

The Farm Security and Rural Investment Act of 2002 (Farm Bill)

This law established a number of programs on energy and biobased products including procurement standards, grant programs, and educational programs for biomass and biofuels. It also reauthorized and expanded funding for the Environmental Quality Incentives Program administered by the USDA which promotes agricultural production and environmental quality goals.

USDA in 2004 established a value-added producer grant program for planning activities and working capital associated with marketing agricultural products and farm-based renewable energy.

Other grants programs have included the Renewable Energy Systems and Energy Efficiency Improvements Program under the Rural Development Office of the USDA. 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.

The Healthy Forests Act of 2003

This Act amended the Biomass Act of 2002 and provided research grants, funding for biomass technologies, and support for purchase of biomass.

American Jobs Creation Act of 2004

This Act contains two provisions that provide tax exemptions for three renewable fuels: ethanol, biodiesel, and wind energy. This bill provides for the first time a federal biodiesel tax incentive (excise tax of $1.00 per gallon of agri-biodiesel) that is used in blending with petroleum diesel, and a 50-cent credit for every gallon of non-agri-biodiesel (recycled oils).[25]

The Energy Policy Act of 2005

The Energy Policy Act was signed into law on August 8, 2005. Among other things, this Act amends the Clean Air Act and introduces a series of measures oriented to reduce petroleum dependency and encourage the development of renewable fuels markets. The Act intends to establish a comprehensive, long-range national energy policy, providing incentives for production of traditional energy sources and also for newer, more efficient energy technologies. The law also provides incentives for energy conservation. It contains many new research and development programs while making changes to current energy policy.

Other Federal Programs

Economic Action Programs

The Forest Service provides grants through its Economic Action Programs (EAP), created to help rural communities and businesses dependent on natural resources become sustainable and self-sufficient. In 2003, according to Forest Service officials, the Forest Service funded 73 projects related to woody biomass utilization; grants ranged from $5,000 to $225,000, for a total of about $3.5 million.[26]

State Energy Program

This program provides grants to states to design and carry out their own renewable energy and energy efficiency programs. States manage the funds and are required to match 20 percent of the DOE grants. In 2004, about $44 million was directed in grants to the states, and another $16 million was directed to special state projects.[27] In 2004 the DOE announced that it will provide through the State Energy Program Special Projects the amount of $2.1 million to the state of California to provide grants for 17 energy efficiency and renewable energy projects.[28]

State Technologies Advancement Collaborative Program

This collaboration of the National Association of State Energy Officials, the Association of State Energy Research and Technology Transfer Institutions, and the U.S. Department of Energy provides funding for state energy efficiency and renewable energy projects.[29]

The Tribal Energy Program

This program of the Department of Energy promotes tribal energy sufficiency, economic development, and employment on tribal lands through renewable energy and energy efficiency technologies.[30]

The Sustainable Agricultural Research and Education (SARE) Program

This program administered by the USDA assists farmers in adopting sustainable agricultural practices. The program administers grants including Producer Grant Projects and Research and Education Projects.[31]

FEDERAL POLICIES ENCOURAGING ETHANOL PRODUCTION

The Farm Security and Rural Investment Act of 2002 (Farm Bill)

Two provisions of the 2002 farm bill have encouraged research in cellulosic ethanol production.[32] The first provision allows for the use of Conservation Reserve Program lands for wind energy generation and biomass harvesting for energy production.[33] Another provision provides incentives for production and use of non-traditional biomass feedstock through funding for research and development projects on biofuels and biomass-based chemicals.[34]

American Jobs Creation Act of 2004

Since 1978 the U.S. government has been encouraging ethanol fuel production and use through tax incentives.

The primary mechanism of the federal ethanol incentive is a reduction in the federal excise tax collected on sales of gasoline when gasoline is blended with ethanol. Until 2004, there was a reduction of 5.1 cents per gallon for ten percent ethanol blends (E-10). Ethanol blends of 5.7 and 7.7 percent also had proportionately reduced rates per gallon. This incentive was originally authorized through 2007, but decreased from 52 cents for each gallon of ethanol to 51 cents starting in 2005. On October 22, 2004, President Bush signed into law the American Jobs Creation Act of 2004. This bill established the Volumetric Ethanol Excise Tax Credit (VEETC) extending the ethanol tax incentive of 51 cents a gallon until 2010 and basically replacing the excise tax exemption with an equivalent immediate tax credit.

The American Jobs Creation Act of 2004 eliminated the need of the alcohol fuels income tax credit and simplified the system of excise tax collection. It also provided more flexibility to gasoline refiners, marketers, and ethanol producers. The law eliminated the restrictive blend levels (5.7%, 7.7% and 10%) allowing oil companies to blend as much ethanol as needed to meet their octane or volume needs. Under the new law, any taxpayer eligible for the alcohol fuels tax credit is able to file for a refund for every gallon of ethanol used.[35]

The American Job Creation Act of 2004 allows the apportionment of the small ethanol producer tax credit among patrons of a tax-exempt cooperative,[36] and provides for additional cooperative and agriculture provisions that benefit cooperatives by farmers.

The Energy Policy Act of 2005

The Energy Policy Act was signed into law on August 8, 2005. Among other things, this Act amends the Clean Air Act and introduces a series of measures oriented to reduce petroleum dependency and encourage the development of renewable fuels markets. The most important aspects of the law affecting ethanol producers are:

- The bill includes incentives for the production of renewable fuel from these "non-traditional" sources, allowing greater credits for ethanol derived from cellulosic biomass or waste. Every gallon of cellulosic or waste derived ethanol counts as 2.5 gallons towards the renewable fuel program requirements.
- Amends the Clean Air Act to include renewable fuel definitions and provides funds for the creation of a cellulosic biomass ethanol and municipal solid waste loan guarantee program to carry out not more than four commercial demonstration projects for cellulosic biomass and sucrose-derived ethanol. Guarantees under this section can be issued for up to 80 percent of the estimated cost of a project, not to exceed $250 million per project.
- Amends the Clean Air Act to provide grants to merchant producers of cellulosic biomass ethanol, waste-derived ethanol and approved renewable fuels to assist with building of production facilities. It authorizes $100 million in FY 2006, $250 million in FY 2007, and $400 million in FY 2008 for these grants (Section 1512).
- Creates an Advanced Biofuels Technologies Program to be established by EPA in consultation with DOE and the Biomass Research and Development Technical Advisory Committee. This program funds demonstrations of advanced technologies for the production of alternative transportation fuels including the development of not less than four different conversion technologies for producing cellulosic biomass ethanol and for developing not less than five technologies for co-producing value-added bio-products. The program authorizes $550 million per year for fiscal years 2005 through 2009 (Section 1514).
- Provides funds for the cost of loan guarantees to carry out commercial demonstration projects for ethanol derived from sugarcane, bagasse, and other sugarcane byproducts. Loan guarantees can be for up to 80 percent of estimated project costs, not to exceed $50 million per project (Section 1516).

- The Act modifies the small ethanol producer credit allowing producers of up to 60 million gallons per year to qualify for the credit.

Other Federal Programs

USDA's Incentive Payments

The U.S. Department of Agriculture's Bioenergy Program provides incentive payments (contingent on annual appropriations) on year-to-year production increases of renewable energy.[37] The USDA also provides financial assistance in the form of grants, loans, and financing with commercial lenders to construct and operate ethanol production facilities. Technical assistance and information resources are also available. California farmers should be able to take advantage of these programs.

Financial Assistance Provided by the Rural Development Office of the USDA

This office provides financial assistance in the form of grants and loans to improve the economy and quality of life in rural America. These programs can assist entities seeking to develop and build an ethanol production facility.[38]

FEDERAL POLICIES ENCOURAGING ETHANOL USE

The Alternative Motor Fuels Act of 1988

Beginning in fiscal year 1990, this Act called for the federal government to acquire the "maximum practicable" number of light-duty alcohol and natural gas vehicles. It also established an Interagency Commission on Alternative Motor Fuels to develop a national alternative fuels policy. A commercial demonstration program to study the use of alcohol and natural gas in heavy-duty trucks was also established under this Act. Since 1991 the Department of Energy has been supporting projects in this area, making the data available through its Alternative Fuels Data Center.[39]

Clean Air Act Amendments of 1990

Air quality regulations that contribute to the use of ethanol for gasoline blending include:

- The phase out of lead as a gasoline octane-enhancing additive. Lead in gasoline was completely banned in 1995, since it is toxic to humans and disables emissions control devices. This measure was largely positive for ethanol producers resulting in greater use of ethanol. Lead was used to raise the octane rating of gasoline. Ethanol also raises the octane rating of the fuel while reducing emissions at the same time. Therefore, as lead was removed from gasoline, gasoline producers used oxygenates such as ethanol to offset the loss in octane rating.

- The introduction of oxygenated gasoline requirements. The use of ethanol has been stimulated by the Clean Air Act Amendments of 1990. Ethanol is primarily used in gasoline to meet minimum oxygenate requirements of two Clean Air Act programs, the reformulated gasoline (RFG) and the oxygenated fuel programs. The oxygenated fuel program, which required that ethanol or another oxygenate be mixed with gasoline in areas with excessive carbon monoxide, terminates with the passage of the Energy Policy Act of 2005.

The Clean Fuel Fleet Program

Established by The Clean Air Act Amendments of 1990, this program requires that cities with significant air quality problems promote vehicles that meet clean fuel emissions standards. Although it imposes similar requirements to those for the Energy Policy Act, it allows for the use of conventional vehicles as long as they meet National Low Emission standards.

The Energy Policy Act of 1992

The Act requires that the federal government, state governments, and businesses in the alternative fuel industry purchase alternative-fueled vehicles. It also established tax deductions for the purchase of alternative-fuel and hybrid vehicles.[40] Under this Act, California and local government are required to purchase 75 percent of their non-exempt light-duty vehicles as alternative fuel vehicles (including flexible-fuels vehicles that can burn variable mixtures of ethanol). However, flexible-fuel vehicles can operate on 100 percent gasoline and are not actually required to use an alternative fuel. Changing this situation in California will be difficult due to the lack of the necessary fueling infrastructure to support the use of these vehicles.[41]

The Working Families Tax Relief Act of 2004

The Working Families Tax Relief Act of 2004 extended credits established by the Energy Policy and Conservation Act (EPCA) of 1975 provided for manufacturing incentives for alternative-fuel vehicles including ethanol vehicles.[42] Credits will expire after 2006.

The Energy Policy Act of 2005

This Act defines a Renewable Fuel Program to be established by EPA (Section 1501). This program requires that gasoline sold in the United States contain a specified volume of biofuel. It sets a schedule and amounts for introduction of renewable fuel content for gasoline in the U.S. for 2006 through 2012. For years after 2012 EPA will set the schedule and new amounts. The program also establishes a minimum volume for renewable fuel derived from cellulosic biomass of 250 million gallons, starting in 2013 and thereafter.

The Act provides refiners flexibility by creating renewable fuel standards credits (for renewable fuel blended above baseline) that have a lifespan of 12 months. Starting in 2013 and thereafter, the amount of fuel additives would be determined by the Environmental Protection Agency (EPA) and the Agriculture and Energy departments, and would be based on the experience of increasing fuel additives in the previous seven years.

The Energy Policy Act of 2005 contains a number of provisions designed to encourage development and utilization of alternative fuels:

- Includes programs to provide alternative-fueled vehicles for municipalities and schools.
- Strengthens the requirement for federal alternative-fuel fleets to ensure these vehicles actually use clean alternative fuels and requires the Secretary of Energy to report to Congress the effect of the law on the development, availability, and costs of alternative-fueled vehicles.
- Authorizes $200 million for an advanced vehicle program. This program, operating under the current Department of Energy "Clean Cities" program, would provide grants to state and local governments to acquire alternative-fueled and fuel-cell vehicles, hybrids, and other vehicles, including ultra-low sulfur diesel vehicles.
- Offers business and consumers tax credits for the purchase of alternative-fuel and hybrid vehicles. The value of the tax credit ranges from $2,000 for smaller, personal cars, to $40,000 for the purchase of buses, etc.
- Provides a 30 percent credit (up to $30,000) for investments in alternative-fuel refueling stations. Qualifying fuels include E-85, natural gas, hydrogen, and biodiesel, among others. The credit expires after December 31, 2007.
- Creates the joint flexible fuel hybrid vehicle commercialization initiative to improve technologies for the commercialization of hybrid/flexible-fuel vehicles. The program is intended to reduce petroleum consumption by bringing new clean technologies to the market faster.

STATE POLICIES FOR BIOMASS UTILIZATION

Although a number of incentives have been established, few at the state level are targeted specifically at biomass and there is no specific policy identifying the need for increased and improved utilization or to comprehensively address biomass as a resource.

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.[43]

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. The Existing Renewable Facilities Program is divided into two tiers, with biomass and solar thermal in Tier 1 and wind in Tier 2, and offers support through production credits, as does the New Renewables program. The Emerging Renewables program provides rebates for certain renewables to grid-connected utility customers within the PG&E, SCE, and SDG&E service territories. For biomass, the rebate would apply to fuel cells using renewable fuels.[44]

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.

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.[45]

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. The program provides incentive grants at a rate of not less than $20 per ton with no single grant exceeding $300,000. Projects must also demonstrate environmental benefits and the ability to assist in developing a market for rice straw not dependent on government assistance.

The CPUC Self-Generation Incentive (SELFGEN) Program. This program is designed to encourage customer-owned grid-connected renewable and distributed generation (DG) to help meet on-site energy needs. In 2003, AB 1685 extended the program until 2007. Incentive payments are $1 to $4.50/W, depending on the technology employed. Incentives for biomass are available for fuel cells, micro turbines, small gas turbines, and internal combustion engines operating on renewable fuels up to a maximum capacity of 1.5 MW.[46]

The Dairy Power Production Program. This program was established under SB 5X (2001) and provides two support mechanisms: cost buy downs and incentive payments. The program is intended to reduce environmental impacts of dairies, particularly nitrates in groundwater and greenhouse gas and pollutant air emissions, and to increase peak electricity generation. The program has awarded 14 projects to date and $5.8 million and it is administered by the Western United Resources Development, Inc. for the CEC.[47]

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.

STATE POLICIES THAT HELP THE ETHANOL INDUSTRY

In California there is no specific policy incentive for ethanol production. However, ethanol/gasoline blends are subject to the state gasoline excise tax. Since alcohol fuels are taxed at one-half the prevailing California gasoline excise tax rate, purer forms of ethanol (E-85) have a rate of about 70 percent of the gasoline excise tax rate on an energy equivalent basis.

Financing. Two existing bond financing programs could be available to ethanol producers: 1) the California Alternative Energy and Advanced Transportation Financing Authority (CAEATFA) that finances facilities that use new energy sources and technologies, and finances development of advanced transportation technologies, and 2) the Pollution Control Tax-Exempt Bond Financing Program that provides private activity tax-exempt bond financing to California businesses for the acquisition, construction, or installation of qualified pollution control, waste disposal, waste recovery facilities, and the acquisition and installation of new equipment. However, ethanol producers, particularly those producing cellulosic ethanol, have been unable to meet lending requirements for those programs (for example, they cannot obtain a letter of credit from a qualified financial institution due to the infant state of cellulosic ethanol conversion technologies). Hence, the producers that most need financing are the least likely to qualify.

California Reformulated Gasoline Regulations. These regulations have not encouraged the use of ethanol in the past few years because, according to the California Air Resources Board, reformulated gasoline under California law is cleaner for the environment than blends with low levels of ethanol. The use of ethanol in the state was mandated by the oxygenate requirements of the Clean Air Act. After the ban of the use of MTBE in California (2002), ethanol use increased significantly. The Energy Policy Act of 2005 will change the picture, depending on CARB policies on air quality and their recommendations regarding the use of ethanol.

Other Policy Actions Benefiting Ethanol

Assembly Bill 2076 (Shelley, Chapter 936, Statutes of 2000) required that the Energy Commission and the California Air Resources Board develop and submit a plan to the Legislature to reduce petroleum dependence in California. The Energy Commission and CARB held public workshops and meetings with environmental groups and representatives of the oil, natural gas, ethanol, and diesel engine industries to address these issues. The plan established both near-term and mid- to long-term strategies to reduce the demand for petroleum fuels in California, including the use of alternative fuels.

Senate Bill 1170 (Sher, Chapter 912, Statutes of 2001) required the Energy Commission, the California Air Resources Board, and the Department of General Services to examine strategies to reduce petroleum consumption in the state fleet by no less than 10 percent on or before January 1, 2005.

The state currently owns 1,649 flexible fuel vehicles capable of running on E-85. However these vehicles currently run on gasoline because California lacks a retail fuel infrastructure to dispense the alternative fuels used in the vehicles. Another problem impeding the increase of flexible fuel vehicles (FFVs) in the state fleet is that current manufacturers of these vehicles do not meet state fleet procurement vehicle specifications. In January 2003, the Department of General Services adopted a new policy eliminating the option of purchasing FFVs (or any other type of alternative-fueled vehicles), which uses fuel that is not widely available in California. Thus, the existing 1,649 FFVs are to be gradually phased out of the state fleet.[48] This situation could change with the passage of the Energy Policy Act of 2005.

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[41] California Energy Commission. *California State Vehicle Fleet Fuel Efficiency Report: Volume II.* Consultant Report. Sacramento: the Commission, April 2003.

[42] Some important energy tax incentives were extended or adopted in the Working Families Tax Relief Act of 2004 (P.L. 108-311) and the American Jobs Creation Act of 2004 (P.L. 108-357).

[43] California Energy Commission (CEC). *Biomass in California: Challenges, Opportunities, and Potentials for Sustainable Management and Development.* Op. Cit.

[44] California Energy Commission (CEC). *Biomass in California: Challenges, Opportunities, and Potentials for Sustainable Management and Development.* Op. Cit.

[45] California Energy Commission (CEC). *Biomass in California: Challenges, Opportunities, and Potentials for Sustainable Management and Development.* Op. Cit.

[46] California Energy Commission (CEC). *Biomass in California: Challenges, Opportunities, and Potentials for Sustainable Management and Development.* Op. Cit.

[47] California Energy Commission (CEC). *Biomass in California: Challenges, Opportunities, and Potentials for Sustainable Management and Development.* Op. Cit.

[48] California Energy Commission. *California State Vehicle Fleet Fuel Efficiency. Report Volume I.* Summary of Findings and Recommendations. Sacramento: the Commission, July 2003 (revised).