

PLANNING FOR THE SUSTAINABLE DEVELOPMENT OF BIOMASS IN CALIFORNIA

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ABSTRACT: In April, 2006, California Governor Schwarzenegger issued Executive Order S-06-06 proclaiming the benefits of bioenergy and its potential to help meet the needs of California for clean, renewable fuels and power and called for actions by the state to meet the following targets:

- by 2010, produce 20 percent of its biofuels within California, increasing to 40 percent by 2020 and 75 percent by 2050, and
- by 2010, produce 20 percent of its renewable electricity target from biomass within the State and maintaining this level through 2020.

Subsequently, the state's Bioenergy Interagency Working Group, in its bioenergy action plan, tasked the California Energy Commission to prepare a roadmap for biomass development in the state. The roadmap effort was undertaken by and built on work of the California Biomass Collaborative, a coalition of industry, state and federal government agencies, academia, and environmental organizations.

This paper summarizes the process used to develop the roadmap and the resulting recommended actions which are discussed within each of five priority areas:

- *Resource access and feedstock markets and supply,*
- *Market expansion, access, and technology deployment,*
- *Research, development, and demonstration,*
- *Education, training, and outreach, and*
- *Policy, regulations, and statutes*

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1 BACKGROUND

In April, 2006, Governor Schwarzenegger issued his Executive Order S-06-06 calling for California to greatly increase its share of biofuels production and the generation of electricity from biomass resources within the state.

The order stemmed from the following concerns:

- Intensifying public concerns over escalating fuel costs, heavy reliance on petroleum, and climate change,
- Strong state agency advocacy and commitment for improving biomass resource management and mitigating climate change,
- Legislative actions promoting growth in renewable energy and control of greenhouse gas emissions,
- Pronouncements at the federal level signaling greater support for bioenergy, and
- The promise of new technologies for stimulating economic development, improving environmental performance, and realizing the potential offered by biomass in meeting an increasing share of the state's energy demand.

The governor's executive order proclaimed the benefits of bioenergy and its potential to meet the future needs of the state for clean, renewable power, fuels, and hydrogen, and called for the state to meet the following targets for biofuel and biopower development:

- By 2010, produce 20 percent of its biofuels within California, increasing to 40 percent by 2020 and 75 percent by 2050, and
- By 2010, produce 20 percent of the renewable electricity target from biomass resources within the State and maintaining this level through 2020.

The order also specified certain actions by the state agencies regulating economic and environmental affairs to achieve the targets, including coordination on the development of research and development plans.

The governor's executive order was followed in July by the release of the state's bioenergy action plan which reaffirmed the targets for producing biofuels and biopower, and, following an earlier proposal by the California Biomass Collaborative, tasked the California Energy Commission with the preparation of a roadmap [1] to provide detailed guidance for research, development, and demonstration activities on biomass. The roadmap effort was incorporated into a larger Collaborative strategic planning effort for biomass development.

The roadmap has been prepared primarily by the executive board and staff of the California Biomass Collaborative with public input and builds on efforts at both the national and state levels to increase the use of biomass for energy and products. [2,3,4,5] It is intended to inform and guide policy makers, law makers, regulators, investors, researchers, and developers involved with biomass and energy issues in California,

but should be of interest to anyone concerned about environmental impacts, sustainable resource management, our current use of fossil fuels, and our future energy strategies.

The roadmap was developed over the course of a year. In early 2006, the Collaborative board held a series of strategic planning meetings in which board members contributed analyses in their areas of expertise. A public workshop dealing with environmental issues surrounding biomass development had been held in November of 2005. At that workshop, many concerns were identified on the impacts of producing, collecting, and processing biomass resources. Many of those concerns were also assigned for analyses.

The Collaborative staff was given responsibility for consolidating and integrating the various elements. The first draft roadmap was distributed to the public for review and comment at a workshop held in September, 2006. Revisions were made and a California Energy Commission-sponsored workshop was held in November, 2006 where further public input was solicited. The comments were evaluated and incorporated in the final document. A second phase planning process is currently underway for state and industry implementation of roadmap recommendations.

2 ENERGY POTENTIALS

The diversity of California's biomass resources makes for many opportunities. But it also makes for greater complexity in attempting to achieve large increases in energy and products. At present, the three principal resources are agricultural residues, forestry residues, and biomass from urban and industrial wastes. These resources are distributed variously throughout the state (Figure 1).

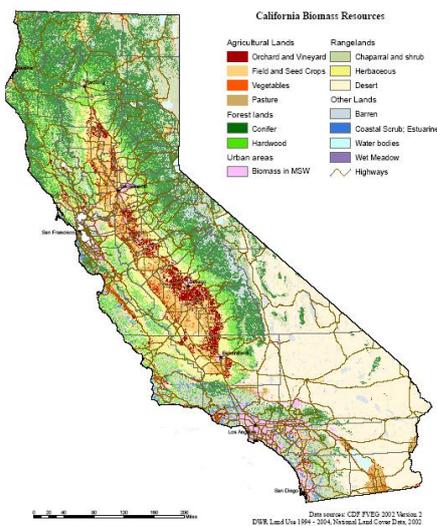


Figure 1. Land classification and distribution of biomass resources in California

Forest biomass is available mostly in the northern and

central mountain areas, agricultural biomass in the Central Valley and coastal and southern valleys, and urban biomass in the main metropolitan regions of the Los Angeles basin, the San Francisco Bay area, San Diego, and the Bakersfield to Sacramento Corridor. By 2020, the state could triple its biomass-to-electricity generating capacity and increase its production of biofuels a hundred-fold, both from resources now considered feasible to use as feedstock and through at least a modest increase in dedicated biomass crops.

By 2050, if the state shifts to greater use of hydrogen in transportation and other energy sectors, biomass could be supplying a large amount of renewable hydrogen. Greater use of combined heat and power systems fueled by biomass could reduce demand for natural gas in process and industrial heat and cooling operations, helping to increase overall energy efficiency and reduce carbon impacts of the state.

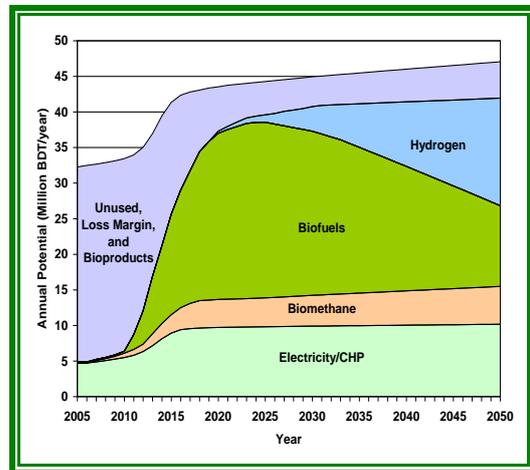


Figure 2. Potential Biomass Tonnage in California

Major opportunities for in-state biomass development include: expansion to nearly 2,500 megawatts of electric power and 18 billion kilowatt-hours of electrical energy, one to two billion gallons per year of biofuels, 100 billion cubic feet of biomethane, and more than a million tons per year of hydrogen.

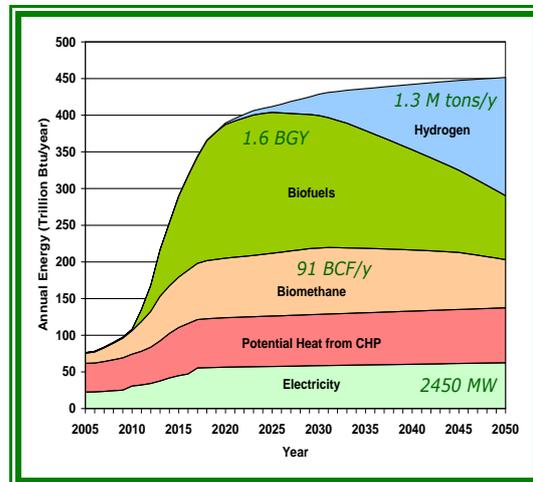


Figure 3. Biomass Energy Potential in California

But California's energy appetite is huge—peak power demand in excess of 50,000 megawatts with annual electrical energy consumption of 300 billion kilowatt-hours, gasoline and diesel fuel demand approaching 20 billion gallons per year, and natural gas consumption of more than 2 trillion cubic feet per year. Potential contributions from current biomass resources are about five to ten percent of state demand in transportation with similar levels in the electricity and natural gas sectors. Improvements in energy use efficiencies would decrease fossil fuel use thereby increasing the biomass contribution from a fifth to a third of energy supply in selected sectors. Simultaneously, biomass can be augmenting supplies of high-value chemicals, structural materials, and other renewable bio-based products with improved environmental and consumer health attributes.

2.1 Critical path

The critical path to accomplishing these contributions from biomass involves stimulating the necessary capital investments to build production capacity and infrastructure, accessing markets for sales of products at prices justifying investments, maintaining sustainable supplies of feedstock, and having appropriate technologies and processes for meeting standards for environmental performance and environmental justice.

The intimate association of biomass production and use with other natural resource and waste management concerns means that there is not always consensus on how best to achieve the potential benefits offered by expanded development. A challenge for policy is to accomplish the compromise needed to satisfy the expressed goals of the state in increasing fuels and power from biomass.

2.2 Barriers and opportunities

Biomass resources can be used to generate renewable power, to produce renewable fuels such as ethanol, methanol, hydrogen, biodiesel, syngas, synfuels, and biomethane, and as feedstock for products such as plastics, solvents, inks, and construction materials. All of these can help meet state goals to expand renewable energy, reduce petroleum dependency, provide economic development, and improve environmental quality.

Benefits of using biomass include:

- reducing the severity and risk of wildfire,
- improving forest health and providing watershed protection,
- improving air and water quality,
- restoring degraded soils and lands,
- reducing greenhouse gas emissions,
- improving management of residues and wastes,
- reducing dependency on imported energy sources,
- creating new economic opportunities for agriculture and other industries,
- improving electric power quality and supporting the power grid,
- creating jobs, and
- economically revitalizing many agricultural and rural communities.

Despite these benefits, there remain a number of barriers to development:

- biomass feedstock acquisition costs add to cost of production, reducing economic competitiveness,
- limited long term contracting opportunities make financing difficult,
- siting and permitting processes can be arduous and complex,
- utility interconnection processes can be difficult and expensive and net metering is not uniformly available for all forms of biomass generation within capacity limits,
- many new technologies remain to be fully demonstrated and commercialized,
- there is limited public awareness of the benefits and costs of biomass management.

Overcoming these and other barriers will take a concerted effort in technology and policy development as outlined in what follows.

3 ROADMAP OVERVIEW

The roadmap begins with an overview of opportunities, challenges, and constraints for biomass, discusses possible scenarios for future development, and introduces priority areas for future actions. Objectives for future actions are centered on the main goals for improving resource production and acquisition and increasing the use of biomass for power, heat, biofuels, and bio-based products.

Goals include demonstrating and commercializing new technologies; supporting new bio-based industries that must compete with established conventional suppliers of energy, fuel, and products; recognizing the resource value of biomass in substituting for declining reserves of fossil fuels and reducing greenhouse gas emissions; conducting necessary research, and ensuring that the public is fully informed about the impacts and benefits associated with biomass.

Recommended actions are associated with each of five priority areas:

1. *Resource access and feedstock markets and supply:* Feedstock suppliers need access to biomass resources and must be able to deliver feedstock into biomass markets year round in sustainable ways and at acceptable prices.
2. *Market expansion, access, and technology deployment:* Power plants, biorefineries, and other biomass converters require access both to firm biomass feedstock supplies and to product markets. Market access in turn requires both physical capacity to deliver product through power lines, pipelines, trucks, and other transport systems, and the ability to price product competitively.
3. *Research, development, and demonstration:* New technologies need commercial demonstration and deployment to produce new fuels and additional renewable bio-based products. Continuing advances stemming from well supported basic and applied research should be sought in new product development, improved product quality, increased conversion efficiency,

improved environmental performance, and better protection of public and consumer health and safety.

4. *Education, training, and outreach:*

Supporting resource, market, and technology developments must be education, training, and public outreach to develop new information, crops, and technologies, provide skilled personnel, disseminate information and establish public dialog over the many issues of concern.

5. *Policy, regulations, and statutes:* The state's policies, regulations, and laws will influence public behaviors, technology implementation, resource management, and markets. These need to be comprehensive, allow for effective innovation, and have a vision of the long-term potential. They also need to provide a clear path for permitting new facilities while ensuring public health and safety and environmental quality.

3.1 Major actions

The diversity and breadth of topics addressed within this framework leads to many issues of concern and recommendations for future biomass development. However, a few major actions will have a large influence on motivating technical and economic changes that will be needed to achieve the roadmap goals.

Foremost among these are:

- *Carbon policy:* Implementing and expanding state carbon policies to meet or exceed greenhouse gas emission reduction targets and sending clear price signals to producers and consumers for encouraging more rapid adoption of higher efficiency technologies and renewable resources will be critical for meeting targets for biomass as well as overall state objectives in renewable energy. Through Assembly Bill 32, California's global warming solutions act, and other legislation, California is already embarked on major initiatives to reduce greenhouse gas emissions and establish carbon markets that will provide needed economic support and stimulate increasing investment.
- *Standards and best practices for sustainability:* Establishing and employing independently certified performance standards and improving best management practices implemented through both state and industry enforcement will be necessary to build consensus and achieve compromise on environmental and public health and safety issues. Crediting suppliers and producers who meet sustainability standards will provide much needed economic support while avoiding other costs arising from fire suppression and mitigating environmental degradation.
- *Financing and contracting:* Ensuring the ability to finance and support biomass development by providing state-backed loan guarantees, government procurement programs, long-term contracting and other financial mechanisms supporting biomass projects commensurate with the benefits created is essential to stimulating the level of investment necessary to build the production capacity and infrastructure needed under the governor's executive order.

- *Permitting:* Improving communication among agencies and educating developers as to regulatory and permitting requirements will make the permitting process less arduous. Consolidating permitting activity within interagency coordinating bodies or through master agency agreements where agencies work under one regulatory framework would likely expedite review, improve communication regarding cross-media impacts, and reduce permitting costs, both for developers and the agencies. Establishing a clearer permitting pathway will be important to stimulating the needed investment for new facilities to meet the state's objectives.
- *Research, development, and demonstration:* Ensuring adequately funded, long-term basic and applied research and conducting well monitored demonstrations are critical to bringing new technologies, resources, and products to commercialization and to improving technical and environmental performance while enhancing effective regulatory decision making and public policy.

3.2 Summary of Specific Roadmap Recommendations

Within each of the priority areas are recommended actions intended to help achieve the targets and realize the longer term vision of sustainable development.

Resource access and feedstock markets and supply:

Any long term, sustained use of biomass ultimately depends on sustainable acquisition practices to grow, collect, and store the resource and deliver it as feedstock to market.

Biomass feedstock supplies will expand due to policies and technological innovations resulting in greater competitive status in energy and product markets. Actions to secure access and long-term supply include:

- requiring the application of best management practices for resource development, production, and extraction allowing both industry and state enforcement of standards. Where standards do not yet exist, new standards should be developed;
- establishing processes for independent certification of sustainable practices including
 - land and water use,
 - environmental impacts,
 - environmental justice, and
 - resource and environmental monitoring;
- establishing a biomass commodity market and commodity board or commission to facilitate
 - biomass marketing,
 - development of production, collection, transportation, storage, and processing infrastructure,
 - and coordination of sustainable business certifications;
- crediting sustainable suppliers of feedstock through tax incentives or subsidies in recognition of other costs avoided;
- providing state assistance in funding collection and processing efforts initially;
- providing access to extensive biomass resource and market information.

Market expansion, access, and technology deployment:

For any new biomass capacity added, whether for power, fuels, or products, access to market is crucial. Providing adequate infrastructure for product delivery depends on:

- ensuring adequate physical infrastructure for
 - electricity transmission lines and interconnection,
 - gas pipelines and transportation fueling systems,
 - feedstock storage, transportation, and processing capacity;
- establishing policies and enacting necessary laws to monetize external benefits and stimulate needed investment through
 - new opportunities for long term contracting,
 - tax credits,
 - price supports and loan guarantees,
 - carbon markets,
 - environmental credits,
 - reopening direct access to electricity markets
 - and other financial incentives.

Market expansion can only occur if additional biomass capacity is installed. Near term deployment should target:

- upgrading or repowering existing power plants where needed,
- adding new power generation capacity including distributed generation,
- support use of distributed residential biomass (i.e., wood/pellet stoves when and where appropriate),
- expanding landfill gas and other biogas systems to produce power and fuels including the adoption of bioreactor landfills,
- adding new source separation, waste-to-energy and other conversion capacity for biomass in MSW,
- expanding the use of biodiesel and other renewable diesel fuels including use as blendstock for conventional diesel,
- expanding E85 and other biofuel distribution and fueling capability,
- adding compressed and liquefied biomethane capacity,
- ensuring adequate feedstock collection, separation, and harvesting equipment,
- and show investment community that biomass technologies can be profitable
- promote the re-establishment of PURPA SO4-type contracts,.

Longer term deployment should be planned in concert with research and demonstration of new technologies and processes. Particular attention should be paid to:

- siting advanced integrated biorefineries incorporating both biochemical and thermochemical conversion and producing multiple value-added fuels such as ethanol and Fischer-Tropsch liquids, hydrogen, and products as well as electricity,
- replacing existing power facilities with more advanced systems such as biomass integrated combined cycles (BIGCC) and increasing use of combined heat and power (CHP),

- increasing renewable power capacity by creating a hybrid system to take advantage of stored energy in biomass in complementing intermittent renewable power from wind and solar systems,
- integrating specialized bioenergy and other biomass crops into agricultural systems,
- integrating crude biomass-derived fuel intermediates as feedstocks to conventional petroleum refinery operations,
- promote biopower for plug-in vehicles,
- and expanding hydrogen distribution systems.

Research, development, and demonstration:

A substantially increased research effort will be needed as California develops and expands its use of biomass and implements renewable and low-carbon technologies to reduce reliance on petroleum and other fossil fuels. State research programs should build on and be coordinated with extensive strategic research plans developed at the state and national level while targeting specific areas of emphasis for California focusing on:

- conducting comprehensive life cycle assessments and health risk assessments systematically comparing waste and resource utilization alternatives;
- determining best management practices and monitoring environmental, health, and safety impacts from
 - feedstock production
 - feedstock handling and processing
 - conversion technology and manufacturing
 - product utilization;
- conducting basic bioscience, biotechnology, and biochemical research to
 - improve sustainability of biomass production systems
 - increase yields
 - reduce water and other agronomic inputs
 - increase disease- and pest-resistant of biomass crops
 - improve conversion processes and product quality;
- conducting applied research and demonstrating commercial scale biomass conversion and biorefinery techniques
 - biological, physical, chemical, and combined pre-treatment processes
 - lignocellulosic fermentation
 - advanced power generation including integrated gasification combined cycles and fuel cells
 - thermochemical biomass-to-liquids (BTL) processes employing Fischer-Tropsch and other techniques for making renewable diesels, gasolines, alcohols, and other fungible products
 - advanced high-rate anaerobic processes for biomethane production and integrated waste management
 - advanced integrated biochemical and thermochemical biorefineries for improved yields and cost;
- modeling, remote sensing, systems analyses, and systems optimization for
 - land use monitoring and evaluation

- forecasting climate change impacts on biomass and bioenergy systems
- assessing local and state economic impacts
- improving feedstock production and acquisition logistics
- siting and sizing conversion facilities and systems.

Greater coordination and facilitation of research and demonstration should be provided by focused efforts with access to state-of-the-art facilities and equipment. Research centers should be developed through state and industry support to provide enhanced laboratory and pilot capabilities for testing and development of advanced concepts.

Education, training, and outreach:

Informed citizens, consumers, and decision makers are crucial to the successful adoption of bioenergy and other biomass systems. Well trained professionals will also be needed to carry out the expansion envisioned. Greater effort and funding should be directed at:

- educating and informing the public and decision makers about biomass systems and issues in sustainable biomass development,
- informing investors about corporate social responsibility and environmental and social implications of investment decisions,
- conducting outreach to local, state and federal government decision makers, schools, non-governmental organizations (NGOs), sustainability groups, and other public interest groups,
- providing outreach on biomass utilization and establishing early dialog with affected communities where facilities are proposed to ensure environmental justice and direct public involvement,
- holding general and specialized conferences, workshops, and onsite tours to increase information dissemination and encourage public, industry, and scientific interaction,
- conducting hearings and sponsoring field trips for policy makers and regulators to provide relevant information for policy, statutory, and regulatory proceedings,
- providing technical training by and for industry and expanding university curricula and programs to ensure the availability of adequate numbers of skilled professionals and technicians,
- augmenting existing cooperative extension programs to inform and educate farmers, producers, operators, investors, and others of results emerging from research and development efforts,
- providing outreach and coordination with farming organizations and agencies,
- building grade-level appropriate K-12 curricula and teacher training programs to enhance career preparation and public education.

Policy, regulations, and statutes:

California needs to establish an efficient process to address policy and regulatory issues in collaboration with the biomass industry. Only with a broad, overall approach will it be possible to address existing constraints and develop new policies, laws and

regulations that promote the expanded use of biomass while protecting the state's environment. Addressing issues related to biomass may require state agencies to change existing policies or develop new ones. In addition, changes in existing laws or regulations may be required before some of the policies can be fully implemented. Meeting the targets as ordered will require support at the highest levels of state government agencies to develop policies, regulations, and statutes aimed at:

- accounting for externalities and establishing or augmenting financial incentives, including:
 - expanding carbon markets and implementing carbon taxes if necessary to avoid excess leakage across state borders,
 - increasing the value of renewable energy credits and designating allowable emission offset credits,
 - establishing a greenhouse-gas-based biofuel standard similar to the RPS based on fuel carbon content,
 - providing equitable tax credits and production incentives for biomass production and use
 - facilitating long term contracting,
 - providing loan and other financing assistance;
- revising waste management policies and practices including
 - adding extended producer responsibility requirements
 - shifting to disposal-based regulations (e.g., reduce biodegradable material in landfills and reduce per-capita disposal amounts) from the current diversion-based regulations
 - amending laws to revise or eliminate technology and transformation definitions and require greater reliance on performance-based standards and results from comprehensive life cycle assessments
 - changing statutory definitions and permitting authorities to recognize the resource value of biomass in waste;
- requiring and enforcing best management practices where not yet applied;
- revising permitting requirements to enhance interagency communication and create a clear permitting pathway for applicants;
- establishing new or investing existing enterprise zones with responsibilities and opportunities to support biomass development including:
 - siting assistance,
 - local government support,
 - environmental review covering multiple projects,
 - and appropriate incentives;
- implementing environmental justice review,
- enhancing access to transmission lines, pipelines, and other infrastructure, providing equitable policies for net metering, opening direct access, and other incentives intended to stimulate markets,
- expanding the renewable portfolio standard (RPS) as needed
- establishing a renewable fuels standard (RFS),
- requiring greater availability of alternative fuel vehicles.

4 NEXT STEPS

The roadmap provides direction for government and industry action but does not fully address implementation of the recommendations. The state and other stakeholders will need to set priorities for actions to be taken over the near-, mid- and long-term and identify responsibilities for implementing the various elements. Some actions will require legislation; others may be handled by executive or administrative order. Some will require budgetary actions while still others must be accomplished by industry, local government, and/or academia. Outreach in the form of workshops and coordination with community, farming, and sustainability advocates would build support for change. Realizing the vision for sustainable biomass development and achieving the state's bioenergy goals requires a continuing process focused on identifying and assigning responsibilities for implementing the roadmap recommendations.

5 REFERENCES

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