

Economic, Social, and Environmental Effects of Current and Near-term Biomass Use in California

S. R. Kaffka (srkaffka@ucdavis.edu), M.W. Jenner, D. Wickizer, and R.B. Williams.
California Biomass Collaborative (www.biomass.ucdavis.edu)

Introduction: Sustainable use of biomass for energy and bio-products offers multiple economic and environmental benefits. These include, but are not limited to, locally source renewable energy, improved air and water quality and other ecosystem benefits, as well as reducing California's dependence on fossil fuels. All of these bring additional benefits from intensively managing biomass like associated economic growth and enhanced employment, avoidance of catastrophic wildfires, improved public health, and reductions in net greenhouse gas emissions (GHG).

Monetizing or "internalizing" the value of environmental and societal benefits (or costs) due to bioenergy policy initiatives is difficult and dependent on value judgments that can vary across the spectrum of stakeholders.

Morris (1999)¹ estimated the value of ancillary services provided by US biopower including impact categories; criteria pollutant and GHG emissions, forest and watershed health, employment, economic development, etc. Greenhouse gas savings were too optimistic and other assumptions need updating. Bergmann et al. (2006) looked at consumers "willingness to pay" (WTP) for different types of renewable energy to help determine investment strategies in Scotland. A set of "choice experiments" were conducted where impacts on employment, landscape and wildlife effects and changes in air pollution attributes evaluated for windfarms (large, small, on-shore and off-shore) and biomass power plants. Biopower was favored second (behind large off-shore wind power).²

Estimates of current direct economic benefits of biomass use. It is commonly asserted that policies that promote the use of renewable energy lead to higher levels of employment overall.^{3,4} Biomass utilization requires jobs for collection, construction, and facility operations, and creates secondary jobs through local and regional economic impacts. Jobs are created in both rural and urban areas but particularly benefit rural areas where forest and agricultural biomass is located.^{5,6} Estimates of the number of bioenergy jobs vary, but

¹ Morris, G. (1999). Value of the Benefits of U.S. Biomass Power. Subcontractor report to NREL. Golden, CO, NREL/SR-570-27541.

² Bergmann, A., M. Hanley, and R. Wright, Valuing the attributes of renewable energy investments. Energy Policy, 2006. 34(9): p. 1004-1014

³ Jenkins, B. M. (2005). Biomass in California: Challenges, opportunities, and potential for sustainable management and development, CEC-500-2005-160. California Biomass Collaborative.

⁴ Kammen, D.M., K. Kapadia and M. Fripp. 2004. Putting renewables to work: how many jobs can the clean energy industry generate? Report of the Renewable and Appropriate Energy Laboratory, University of California, Berkeley, CA

⁵ Jenkins, B. M. (2005). Op. cit.

⁶ Domac, J., L.K. Richards, and S. Risovic, Socio-economic drivers in implementing bioenergy projects. Biomass & Bioenergy, 2005. 28(2): p.97-106.

range from 3 to 7 per MWe installed capacity (includes plant operation and fuel logistics and support jobs).^{7,8,9}

There were 5,745 GWh of in-state biopower generated and consumed in 2010 (this was 2.8% of all power generated in state)¹⁰. Direct economic impact, as energy revenue, would be about \$575 million (assumes average bioelectricity sales price of \$0.10/kWh). Assuming a 50% increase in biopower production combined with a 1.6 billion gge from a fully developed in-state biorefinery industry, bioenergy revenue and direct jobs are estimated to be \$7.6 billion, and 9,100 jobs respectively (Table). Estimates for job multipliers and other consequential effects from biomass are used here uncritically. Future alternative energy project-specific assessments should more accurately estimate these effects, and are discussed again below.

Environmental and Indirect Economic Benefits are Difficult to Monetize. Ecosystem services (ES) often include metrics for income distribution, localized pollution effects, and sometimes included in the term social justice. These are difficult to define, measure, and even more difficult to assign a meaningful economic value and attribute to specific policy actions. ES includes watershed protection, habitat creation or preservation, public health, ecosystem health and climate regulation¹¹. Markets have difficulty accounting for and pricing these services. In part, many resources are held in common or considered public goods without private ownership. The global atmosphere is just such a public good, making climate change regulation difficult. Ecosystem analysis is difficult, especially prediction of effects from intervention, so determination of costs and benefits is uncertain.

To illustrate the complexities of monetizing these ES, California wildfire prevention provides a salient case study. Policies affecting the use of biomass from forests are especially important in California and are discussed here as an example of costs and benefits from alternative biomass policies.. Fire is a natural feature of the state's forested landscape. Increasingly, however, destructive wildfires result in unproductive loss of biomass, large emissions of criteria pollutants and GHGs , property destruction, adverse public health consequences, and sometimes permanent loss of ecosystem structure and function. These changes in turn lead to increased soil erosion, sedimentation of dams, declining water quality, and habitat and species loss.

Fighting massive wildfires is very costly. Since 2005, wildfires have burned more than 900,000 acres statewide on average, while over the last two decades, the area burned has been increasing. The California Department of Forestry and Fire Protection (CAL FIRE) has estimated the costs of fighting fires on the 200,000 acres in its area of responsibility cost over \$200 million per year for suppression with an associated average

⁷ Kammen, et al., 2004, op cit;

⁸ Morris, G. (1999). Op. cit.

⁹ Thornley, P., J. Rogers, et al. (2008). "Quantification of employment from biomass power plants." *Renewable Energy* 33(8): 1922-1927.

¹⁰ 2010 California Total System Power. Accessed Nov., 2011:

http://www.energyalmanac.ca.gov/electricity/total_system_power.html

¹¹ Kinzig, Perrings et al. (2011), "Paying for ecosystem services-promise and peril." *Science* 334(4)603-04.

property loss over \$100 million annually¹². A recent assessment reported to the PUC by Placer County Air Pollution Control District attempted to summarize the economic costs of current forest management policies and contrast them to a set of policies that include additional (modest) levels of fuel load reduction¹³. Wildfire management costs in California for all sources of data were reported to average approximately \$1.2 billion dollars per year from 2006 to 2010. These costs include those for post-fire landscape mitigation and compensation to landowners for fires related to transmission infrastructure or other public responsibilities¹⁴. Climate change predictions suggest that wildfire losses will increase¹⁵. Aside from accounting for the costs of wildfire suppression, estimating accurately all the costs of diverse ecosystem functions lost from uncontrolled wildfires is difficult. Nonetheless, fuel load reduction in at-risk forests is regarded as a means of minimizing costly and ecologically harmful consequences of intense wildfires¹⁶.

Woody residues derived from fuel load reduction in at-risk forests can be used for biopower or, potentially, biofuels. Placer County has recently estimated the economic benefits from forest biomass use for power in its part of the Sierra Nevada region. They estimate that a modest increase in fuel load reduction that treats an additional 31,000 acres of forest land per year, if converted to power in 50 MW of new locally distributed facilities, would generate an additional 372 GWh per year¹⁷. To treat forests in this way, they assume \$0.055/kWh is paid to the power producer (as a wildfire hazard reduction adder) and estimate the costs to IOU ratepayers to be equal to \$0.15 per month. These values represent the most recent attempt to estimate costs and benefits from fuel load reduction and are consistent in part with some earlier estimates, but they have not been critically reviewed by staff at the California Biomass Collaborative.

The need for integrated assessments to support policy discussion and analyze non-monetary and otherwise incongruent costs and benefits from biomass use for energy.

Agriculture, forestry and other landscape-based activities serve multiple goals. There are several possible, sometimes competing pathways for the use of energy containing municipal solid waste residues. New policy objectives require these sectors to provide feedstocks for bioenergy and bio-based products as a substitute for fossil fuels. State agencies have the responsibility to guide new public investments directed toward this

¹² D. Pimlott 2011., Cal Fire, cited in: Placer County Air Pollution Control District: Opening Comments to October 13, 2011 Renewable Feed in Tariff staff proposal. Rule Making 1105-005, May 5, 2011; and D. Wickizer, Cal Fire, personal communication,

¹³ Placer County Air Pollution Control District: Opening Comments to October 13, 2011 Renewable Feed in Tariff staff proposal. Rule Making 1105-005, May 5, 2011.

¹⁴ Op.cit.

¹⁵ Bryant, B.P., and Westerling, A. L., 2009. Potential effects of climate change on residential wildfire risk in California; CEC-500-2009-048-F. <http://www.energy.ca.gov/2009publications/CEC-500-2009-048/CEC-500-2009-048-F.PDF>; Westerling, A.L., Bryant, B. P., Preisler, H.K., Holmes, T.P., Hidalgo, H.G., Das, T., and Shrestha, S.R., 2009; Climate change, growth, and California wildfire CEC-500-2009-046-F. <http://www.energy.ca.gov/2009publications/CEC-500-2009-046/CEC-500-2009-046-F.PDF>

¹⁶ USFS Southwest Research Station.2009. Biomass to Energy: Forest management for Wildfire Reduction, Energy Production and Other Benefits. California Energy Commission, PIER program. CEC-500-2009-080. <http://www.energy.ca.gov/2009publications/CEC-500-2009-080/index.html>

¹⁷ Placer County Air Pollution Control District: Opening Comments to October 13, 2011 Renewable Feed in Tariff staff proposal. Rule Making 1105-005, May 5, 2011.

goal and to analyze and permit new projects and facilities created for this purpose. Society desires new sources of energy and transformative industries, but does not want false steps that undermine the future productivity of landscape-based systems. Finding the best balance among the costs and benefits these projects create could be called sustainable development. New public laws like AB 118 and AB32 require that sustainability be assessed, including economic costs and benefits, but also non-monitized benefits and values. In many ways this is an unprecedented and difficult requirement and calls for creative analytical approaches that cross existing agency-specific legal authorities and have not been part of past PIER contracts.

All process or systems are subject to perturbation, and change with time, but biological systems are particularly open to unanticipated influences that can affect their performance. Examples include the arrival of a new pest or disease in agricultural systems, and catastrophic fire in forested ecosystems. New public policy regulations or developments like the listing of an endangered species often change the dynamics of natural resource use. Regulations and permit requirements affect the viability of projects. In the biofuel and bio-products sector, rapidly and unpredictably changing technology can alter the relative value of different feedstocks or the comparative advantage of production regions. Means of assessing these interacting factors are necessary to properly direct development that maximizes broadly defined social welfare in the alternative energy sector. The consequences of public policy choices affecting energy are significant. Since uncertainty is large and unavoidable, ensuring the quality and breadth of the assessment process is the most effective means to increase the likelihood of making prudent choices.

Integrated Assessment (IA) seeks to quantify the most important consequences of new projects and policies, and assess the tradeoffs associated, for example with new uses of biomass, particularly feedstock production for biomass energy and bio-based products. To be worthwhile, IA must first be based on sound professional judgment about agriculture, forestry and other landscape production systems. It must include the capacity to understand the capabilities of current and proposed bioenergy transformation technologies and systems and their environmental performance. It then should facilitate comparisons of policy outcomes based on several complimentary quantitative methods including simulation modeling, economic optimization, cost and benefit analysis, life cycle assessment, ecosystem assessment, and policy comparisons. IA also provides a means of evaluating the effects of differing sustainability standards on the provision of alternative, biomass-based energy sources and products within California.

To achieve these objectives, The California Biomass Collaborative would like to expand the range of its analytical and modeling tools and its dedicated intellectual capacity to assess the sustainability implications of selected crop, forest and MSW feedstock production and manufacturing options in California, especially those identified by California Energy Commission and by other sources. New, transparent, web-based tools are needed to aid in the analysis of the sustainability of diverse biomass energy options. Modeling synthesis, including model integration using new software, is an important outcome of the work. Analyses of these types are needed by the California Energy Commission to properly address the public's interest in comprehensive assessment of the consequences of biomass use for energy. A recent study by the National Research Council focused on the Gulf of Mexico and damage from oil

extraction recommended a similar integrated assessment effort for ecosystem services and costs and benefits¹⁸.

Table1. Direct Bioenergy Economic Impact Estimates for California (heat energy not included)

	Feedstock (Million BDT)	Capacity (MW)	Energy (GWh/y) ^a	Direct Jobs ^b	Direct Value (million \$) ^c
Current Biopower		1,000	5,745	5000	574.5
Projected Additional 50% Biopower		500	2,873	2500	287.3
Total Current & Projected Biopower	14.45	1,500		7,500	861.8
<i>Jobs (/Million BDT) and Value (\$/BDT)</i>				519	\$60
		Capacity (Million gge) ^d			
Biofuel Potential in Million gge	18.05	1,676		1,676	6,704
<i>Jobs (/Million BDT) and Value (\$/BDT)</i>				88	\$371
Grand Total	32.5			9,176	7,566

Sources and assumptions:

- 2010 California Total System Power. Accessed Nov., 2011:
http://www.energyalmanac.ca.gov/electricity/total_system_power.html
- Biopower: 5 jobs per MW capacity, Biofuels: 1 job per million gge capacity (Urbanchuk, John. 2011.)
- Assumes \$0.10/kwh and \$4/gge.
- The 1,676 Million gge is derived from the 32.5 Million BDT estimated by Williams et. al. 2008, and subtracting existing rates of feedstock consumption from known biomass power plants and residues. Once the additional 50% increase was accounted for, the balance of 18.05 was mathematically converted to gge via ethanol and biodiesel estimates. A factor of 70 gallons of cellulosic ethanol per ton biomass was assumed.

¹⁸ National Research Council, 2011. Approaches for Ecosystem Services Valuation for the Gulf of Mexico After the Deepwater Horizon Oil Spill: Interim Report.
http://www.nap.edu/catalog.php?record_id=13141