

Effects of Oil Price on Wood Bioenergy

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Introduction

This literature review examines recent work on the relationship between oil prices, wood prices, and consumer demand for biomass as an alternative energy source. By examining relevant externalities – positive and negative – that affect an emerging biomass industry as well as reviewing global experiences in the field, we can better understand the challenges such an industry faces in the United States. Studying the history of alternative energy programs, and biomass energy programs particular will help us begin to craft policy suggestions to encourage more sustainable energy policy that facilitates ecologically and economically sustainable biomass harvest for energy purposes.

Background

Biomass is “organic matter available on a renewable basis [that] includes forest and mill residues, agricultural crops and wastes, wood and wood wastes [and] fast-growing trees,” among other things. (Bergman and Zerbe, 9, 2008) Forest-dependent communities’ biggest supply of biomass comes in the form of wood and wood wastes as well as fast-growing trees. According to Richard Bergman and John Zerbe with the USDA Forest Service, wood biomass is an attractive alternative energy source for environmental and economic reasons. Wood is a renewable resource, though “proper forest management must be practiced to ensure that growing conditions are not degraded during biomass production.” (Bergman and Zerbe, 1, 2008) Burning wood creates very few carbon or sulfur emissions, but “burning wood in the forest does emit significant amounts of nitrous oxide, a greenhouse gas, if either a wildfire or broadcast burning for stand improvement.” (Ibid, 1, 2008) Bergman and Zerbe also note, “Wood is usually less expensive than fossil fuels,” though its price “for use as a fuel can be extremely variable.” (Ibid, 1, 2008) Wood harvest depends on fossil fuels, particularly diesel, and loggers can be particularly sensitive to increases in transport costs, since they are likely to transport logs long distances.

Biomass can be used to generate heat, electricity, or ethanol, though the most efficient use of biomass appears to be for heating. A Swedish study in “Energy Policy” modeled four energy scenarios in which biomass is used for generating electricity and heat, transport fuels, construction materials, other pulp industries such as paper production, or iron smelting in different proportions to determine which proportional uses of biomass will most reduce carbon emissions and oil use. The scenario that devoted the greatest proportion of biomass for heat and electricity generation had the potential to reduce the greatest amounts of carbon emissions and the greatest reduction in oil usage, while the scenario that emphasized biomass ethanol production had the lowest potential for reducing carbon emissions and reduced oil usage by the least in Sweden.

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On a much smaller scale, biomass can heat family homes efficiently and inexpensively. Bergman and Zerbe argue that when “wood is refined into other forms, its value as a fuel increases,” for reasons related to “transportation and storage; improved durability ... and higher energy density.” (Bergman and Zerbe, 8, 2008) According to the authors, conversion of biomass into “pellets and briquettes [provide] most of these advantages, with the exception of higher energy density. These fuels are dry and better energy carriers than wet wood ... Pellets are easily manufactured and provide an excellent fuel for automated controlled burning in pellet stoves and pellet boilers.” (Ibid, 2008)

Externalities Associated With Biomass

Fires Out West

Biomass – when left in forests – presents serious economic costs to surrounding environs. G. Morris notes in “The Value of the Benefits of U.S. Biomass Power,” that,

“If left in place these residues are unsightly, impede forest regeneration, and increase the risk of forest fire. Increasingly, harvesting plans on public and private lands require some form of residue management, which usually means either piling and burning, or removal and use as fuel.” (Morris, 1999, 4)

If fires are left to burn, then the “open burning of biomass residues leads to heavy emissions of smoke and air pollutants.” (Ibid, 5) It is also:

“[A] major source of air pollution in many regions. Open burning produces massive amounts of visible smoke and particulates, and significant quantities of emissions of nitrogen oxides, carbon monoxide, and hydrocarbons that contribute to the formation of atmospheric ozone...” (Ibid, 7)

Harvesting wastewood, small diameter trees, and other biomass products for use as fuel or other value-added goods thus has a positive externality – limiting the risk of forest fires, which cause substantial environmental damage. Though burning biomass:

“[Leads] to many of the same kinds of emissions as the combustion of fossil fuels ... [most] modern biomass plants are required to achieve zero visible emissions... Their emissions of total and sub-micron particulates are also regulated and controlled to stringent levels.” (Ibid, 12)

Fire suppression policies out west have created an enormous build-up of underbrush and small-diameter trees that dry out and catch fire most quickly in the Southwest. When underbrush or small trees catch fire after a lightning strike, the excess biomass provides fuel for blazes that can reach the crown of large-diameter trees. Once the fire reaches the large diameter trees, it becomes very difficult to contain or extinguish the fire, and the damage wreaked by the fire increases immensely: housing is destroyed, erosion occurs, gas emissions increase, watersheds suffer, wildlife dies, the list goes on. Removing biomass could prevent the calamitous extent of damage that occurs in fire-prone zones.

Decline in wood values – Back East

Eastern forests, though less prone to fires, also benefit from the removal of biomass. Excess forest residues in the Northeast choke forest growth, and limit the growth of trees with the greatest added value – large diameter trees used for veneer wood.

Further, environmental habitats can benefit from routine clearing and harvest of biomass. Wildlife – like the Red-Cockaded Woodpecker in Round Oak, GA – benefit from more open habitats. (Georgia Case Study) There are tourism benefits in the East and the West when loggers clear biomass sustainably – mountain bikers and back-country skiers may be more likely to spend money in places where they can easily traverse a wooded slope that is not choked with underbrush or stunted and skinny trees.

There are additional benefits to a dispersion of energy generation centers compared to our current situation with a large “present concentration of large power plants at grid centers in urban areas [that] makes power supply vulnerable to both natural and human-caused destruction.” (Ibid, 13) It would be possible to construct numerous small-scale energy plants fueled by biomass, especially since the “federal government has invested a significant amount of money and effort to develop new technologies and applications for biomass energy, including advanced electricity generating technologies and liquid fuel technologies.” (Ibid, 13) With some infrastructure in place, it would be a manageable challenge to equip more remote rural regions with biomass generated electricity plants. However, substantial investment is necessary for any such comprehensive program.

Finally, the intangible benefits of economically sustaining a community with community resources are important. Morris writes that:

“In addition to the environmental benefits of energy production from biomass fuels, biomass energy production provides important social and economic benefits to rural areas. These include high-quality jobs, the generation of local and regional tax revenues, and energy diversity and supply security for regional and national energy systems. The long-term nature of employment [in biomass energy generation] provides durable improvement and added stability to the local and regional economies surrounding the plants.” (Ibid, 12)

The series “Biomass Success Stories” that the USDA forest service publishes cites the sense of hope that reviving a forest community has for all levels of society. The production of goods unique to a region, the employment of locals, and the hope inspired by doing something local that is environmentally beneficial are intangible goods that can be created through the sustainable harvest of biomass. Policy that promotes these goods may be an important part of a process with far-reaching economic and environmental impact.

History of Biomass Usage in the United States

Though the United States has historically “led the world in renewable energy development for many years,” Eric Martinot, Ryan Wiser, and Jan Hamrin show in their article “Renewable Energy Policies and Markets in the United States,” that the bulk of those innovations occurred under substantial government supervision and involvement. Their article demonstrates a gradual trend toward liberalizing policies meant to encourage the emergence of renewable energy markets that are very different from the initial policies that were meant to support research and innovation in alternative energy sources.

Martinot, Wiser, and Hamrin divide the history of the development of US renewable energy policies and markets into three periods. The first phase, from 1978 to 1990, was called the “PURPA” era after the Public Utilities Regulatory Policy Act in 1978 that “required utilities to purchase power from qualifying third parties,” which were “small renewable generators and cogenerators (combined heat and power)” plants (Martinot, et al, 2004, 1-2) The next phase of renewable energy development, according to Martinot and the other authors, was a period of

staginations that, “[included] a long period of electric power sector restructuring, repeal of federal and state incentives, and sharply lower natural gas prices. Very little capacity was added,” and this period lasted until 1997. (Ibid, 1) By contrast, the third period revisited government intervention – “starting around 1997 ... some of the uncertainty surrounding electricity reform had begun to lessen, and state renewable energy policies that were enacted during restructuring started to take effect.” (Ibid, 1) These innovations included

“Renewables portfolio standards, (RPS), which require utilities to generate or purchase minimum levels of renewable energy... public benefit funds [that] typically collect a small surcharge on electricity sales, [and net] metering policies,” (Ibid, 1)

which “allowed two-way power exchange between a utility and individual homes and businesses with their own renewable power sources.” (Ibid, 2)

Martinot, Wiser, and Hamrin discuss different examples from different states that had varying levels of success with different policies meant to encourage the development of renewable energy. They emphasize the importance of state-level policies: “Most [developments in renewable energy] were due to state and local policies [though] federal support in the form of the production tax also played a role.” (Ibid, 5) According to the authors, the most important and prevalent pitfalls in renewable energy policy involves inconsistency in policy approach, “poorly balanced supply-demand conditions... selective application of the purchase requirement, [and] insufficient enforcement.” (Ibid, 8) RPS programs, the most explicit command-and-control policy used, have a relatively good track record – the authors argue that:

“[An] effective RPS will ... be one in which (1) strong political support and regulatory commitment exists ... (2) clear and well-thought-out renewable energy eligibility rules are applied, (3) predictable long-term renewable energy targets are established to ensure new renewable energy supply, (4) standards are achievable ... (5) credible and automatic enforcement ensures that penalties exceed the cost of compliance, and (6) the standard is applied to electricity suppliers that are credit-worthy and are in position to enter into long-term contracts.” (Ibid, 9)

Thus, any successful policy must not be made in a vacuum – scientist, community, and government participation are essential to any successful RPS.

The other significant policy instruments that Martinot et al cite, Public Benefit Funds (PBFs) and Net Metering policies depend heavily on state intervention. PBFs are designed to “fund electricity-related public benefit programs such as renewable energy, research and development, energy efficiency, and low-income customer assistance.” (Ibid, 10) They are financed “from a variety of sources ... the most common being a surcharge on end-use electricity rates.” (Ibid, 10) Three key models of PBFs exist – project development models issue grants and direct subsidies to “stimulate renewable energy project installation,” industry and infrastructure models use “business development grants, marketing support programs,” and other review and education programs for firms interested in using renewable energy, and investment models use “loans, near-equity, and equity investments to support renewable energy companies and projects.” (Ibid, 11) Many state renewable energy programs are funded through PBF money for different kinds of renewable energy, wind and solar in particular. Political factors play a large role in how states spend the money slated for renewable energy development – the authors note that “some U.S. states are succumbing to short-term financial pressures, losing sight of the long-term societal benefits, and re-appropriating public benefit funds for short-term governmental budget needs.” (Ibid, 11) When state budgets are restricted by financial pressure, federal assistance may be essential to preserving states’ goals to promote more renewable energy development – PBFs that

cannot ensure that their grants will be used for promoting renewable energy will lose all effectiveness for their stated purpose. Net-Metering programs “are a type of renewable energy policy that ... allows the electric meter to run backwards when the on-site facility (usually a photovoltaic or small wind generator) is generating more power than is being consumed on-site.” (Ibid, 12) In principle, this is a novel incentive to install solar panels or wind generators, but in practice, states vary in the amount of reimbursement firms or individuals receive for installing renewable energy generators. While this strategy is less applicable to biomass, it illustrates the potential problems of uniform application and standards that may affect programs as they spread across the country. As before, federal regulation may be necessary for any comprehensive program that is meant to promote use of the renewable energy from solar, wind, or biomass.

Over the years, there has been a trend to policies meant to encourage the creation of markets for renewable energy. Some market instruments include utility green pricing, which places a premium on energy generated from renewable sources, “competitive retail green power sales,” that provide markets “where multiple electricity service companies compete with one another to provide retail customers with electricity,” and renewable energy certificates that “capture or represent the environmental and social attributes associated with renewable energy generation.” (Ibid, 15) This movement has positive and negative aspects. First, the current ideological climate in the United States favors markets for the distribution of any kind of good. Producers of renewable energy benefit from the higher prices that they receive, and consumers can choose whether or not to buy into renewable energy systems. However, the authors indicate, “Competitive retail markets have not guaranteed green power sales... In fact, competitive retail power sales were declining in 2003-2004.” (Ibid, 15) At the same time, utility companies that offer renewable energy options have “established green pricing programs as a form of insurance, to keep their customer base from declining if restructuring is introduced to the state.” (Ibid, 15) Even so, the authors argue that the impact of voluntary programs “has been modest compared to that of RPS and PBF programs.” (Ibid, 15) As the authors note, repeatedly, incentives offered by governments, and programs mandated by governments, have had the most extensive impact in promoting renewable energy generation.

Martinot et al write that biomass power generation “was one of the main beneficiaries of PURPA.” (Ibid, 25) In states with established pulp markets, biomass plants initially used only one source of waste-wood – sawmill residues. However, as more plants were constructed, “and the number of operating sawmills declined, biomass feedstocks broadened to include forest thinnings, agricultural byproducts, orchard removals, and urban wood waste.” (Ibid, 25) This may indicate the potential to create a market for waste wood, but also highlights the importance of locally oriented research on labor and market trends. The impact of sawmill closings must be compared to the potential benefit of biomass power generation before any silvicultural community will sign on to such a program.

Empirical Work

There is a growing number of empirical studies available about the potential costs and benefits of using more biomass for as a renewable energy source. Many countries outside of the United States have more extensive reports on this topic, but the number of US based studies is increasing. The general theme – after all calculations have been made – is that the best way to promote more biomass usage is through a comprehensive policy program that subsidizes biomass harvesters or provides tax incentives that use renewable energy sources. While the best policies will incorporate certain market incentives, non-market command and control policies may be essential to any comprehensive movement toward making biomass more affordable or improving the infrastructure of harvesting biomass.

A study by Irene Henriques and Perry Sadorsky for Energy Economics used a vector autoregression model to examine the impact of oil prices on alternative energy companies' stock prices, and found that "shocks to oil prices have little significant impact on the stock prices of alternative energy companies." (Henriques and Sadorsky, 2007, 1009) They hypothesize that since "investors in technology have a wide array of products to choose to invest in," and since "mass adoption of alternative energy is too far off and uncertain," investors are unlikely to invest predominantly in alternative energy sources even as global oil prices increase due to the risky nature of the market. (Ibid, 1009) They argue further that governments must play a large role in promoting alternative energy investment, through government subsidies, tax incentives, and "by being early purchasers of alternative energy related products." (Ibid, 1009) These results may indicate that increasing oil prices will not be enough to cause a genesis of money-flush renewable energy markets in general, let alone markets for biomass. For more sustained biomass energy development, consistent government intervention that incorporates local assessments of forest capacity and other environmental considerations will be key to any energy policy that needs local support.

A study by Dan Loeffler, David Calkin, and Robin Silverstein estimating volumes and costs of forest biomass in western Montana used forest inventory and geospatial data to evaluate the amount of biomass "available for renewable energy production from fuel reduction treatments." (Loeffler et al, 2005, 32) The authors "integrated a scientifically based fuel reduction/forest health silvicultural treatment with ground-sampled forest inventory data," to "geographically identify and quantify sources of biomass for renewable energy production," in order to determine "the feasibility of potential energy production industries." (Ibid, 32) The authors apply their model to the Bitterroot Valley in Montana, and conclude that – with the (numerous) assumptions that "forest conditions found in the inventory data represent current conditions on the ground," and that "all lands ... would be treated using our selected silvicultural treatment [would] yield the average amount of biomass calculated," among other assumptions of uniform conditions and costs – the cost of harvesting biomass would grow as distance from the harvest site increases. (Ibid, 35) Thus, to avert market failure with respect to the demand for biomass and the rising costs of harvest, government intervention will be important to any program that seeks to increase consumption of biomass as an alternate energy source.

In "Economic Feasibility of an Integrated Harvesting System for Small-Diameter Trees in Southwest Idaho," Han-Sup Han, Harry Lee, and Leonard Johnson argue, "Equipment used to thin small-diameter trees greatly affects the profitability of logging operations and returns to a landowner." (Han et al, 2002, 27) This equipment is expensive, and requires moderately skilled labor to be operated effectively. Further, road accessibility is important in any Idaho thinning operation – and, likely, in any biomass harvesting operation – which represents additional costs to any would-be biomass harvesting operation – "Constructing access roads to the harvesting site is costly and can cause a large negative impact on net return from a small wood-thinning site," and "potential accessibility by a chip van will determine whether materials other than sawlogs can be recovered." (Ibid, 27) The combination of human and physical capital is important to any biomass harvesting project, and job creation may cost more than individuals or firms may be willing to pay for. Given the large entry costs, government assistance may be essential to "creating demand" for biomass as an energy product. Similarly, fuel costs play a huge role in the cost structure of harvesting biomass. As Han et al write, "thinning materials from small-diameter trees carry low market values and typically do not offset high transportation costs associated with long hauling distances." (Ibid, 27) Any project that seriously considers harvesting biomass faces potentially high costs that may be volatile. Government assistance will be essential for smoothing out the costs that biomass harvesting firms will face in their entry to an as-yet non-robust market. Finally, Han et al note that "market prices for forest products vary with geographical location and raw

material demand within a region.” (Ibid, 27) If similar products yield drastically different prices in Idaho and Oregon, then some policy instrument must exist to smooth the inter-regional differences in price and demand if we expect any kind of substantive move toward greater use of biomass as an alternate energy supply.

Several international empirical studies analyze different aspects of biomass markets and policy. For example, an Italian study by Damiana Chinese and Antonella Meneghetti modeled firms’ choices to use biomass energy using mixed integer linear programming. Despite using a fairly complicated optimization model, the authors concluded that “the profitability of [biomass fueled systems] is intensely influenced by the level of subsidies and discounts, i.e., by the level of investments required.” (Chinese, Meneghetti, 2005, 252) In “Potentials for Electricity Production from Wood in Ireland,” R. van den Broek, S. Teeuwisse, and others modeled the potential success of

“biomass based electricity production [using] various biomass resources and a range of conversion technologies, in order to select promising routes for biomass based electricity in the short term.” (van den Broek, Teeuwisse, et al, 2000, 991)

They calculated potential energy yields from different sources of biomass, as well as different methods of burning biomass, and compared the species and techniques to potential reductions in greenhouse emissions over the long run. They concluded that short-term costs of certain promising technologies might be “more expensive, [but] in the long term this technology may offer a competitive alternative.” (Ibid, 1009) As in other studies, an important theme in the European research is the role of long-term focus, and the potential need for government support to clear short-term barriers to entry.

The authors of “Total Costs and Benefits of Biomass in Selected Regions of the European Union,” jump straight into the theme of government support for biomass energy development – they argue that:

“many researchers come to the conclusion that the traditional objective of neo-classical economics, that is, to reach the Pareto optimal state – in which no one can be made better off without making someone else worse off – may be too ambitious with respect to environmental problems.” (Groscurth, Almeida, et al, 2000, 1082-83)

The authors cite many possible benefits of using biomass for energy generation, including the potential to “facilitate waste disposal and reduce ground water pollution,” and note that in Sweden, there is enough support for increased harvest of biomass for external benefits that there is “wide acceptance of the corresponding environmental taxes.” (Ibid, 1093) The authors believe that

“market-based incentives should be used to support the market introduction of biomass-to-energy applications in order to select the most favorable application. Such mechanisms could be fuel taxes, emission taxes, or tradable emission permits, which may be justified as an internalization of external costs.” However, reflecting the *large uncertainties intrinsic in the external cost concept*, levels of such taxes should be determined by the objectives pursued rather than relying mainly on the external costs calculated.” (Ibid, 1094) [Emphasis added.]

Any policy meant to increase consumer demand for biomass as an alternate energy source will depend on some external support. However, the authors’ point that policies should reflect certain market ideals is prudent. This merely emphasizes the need for comprehensive and well-planned

policy that incorporates different levels of expertise, as well as a commitment to a long term plan that will move in a consistent fashion toward certain goals.

Present – Current Biomass Plant Projects

In the US, there are several states with large-scale biomass energy projects. Minnesota, Massachusetts, Vermont, New Hampshire and New Mexico have biomass boilers that generate electricity for different sized facilities. In Vermont, the Mount Abraham High School and Forest Guild of Bristol, Vermont have been working together to clear private land of biomass for use in the school's heating system. They want "to develop a prototype community wood energy model that can be successfully adapted by all 251 towns in Vermont." (Case study – 1 – Mt. Abraham, Bristol, Vermont) Hemphill Power and Light is a biomass powered electricity plant in West Springfield, NH, that uses a large quantity of biomass harvested in Vermont and parts of Massachusetts.

An important feature in the rising interest in using biomass for energy is the price of oil. As people spend more for oil and become more concerned about their carbon footprints, the incentive to use sustainable, local, and relatively carbon neutral sources of energy increases. Part of the Mt. Abraham community biomass project's mission statement is the community's desire to "provide local residents and officials with more control in meeting their local municipal energy needs (including supply source, price, fair access, and distribution)." (Mt. Abraham case study, page 2) However, harvesting wood is an energy intensive process. Part of the cost relates to the physical harvest of wood. The most profitable and efficient biomass harvesting operations depend on up-to-date machinery that typically involves a substantial start-up investment. Another key element of biomass harvest is long transport distances. On the east coast, different biomass projects listed transport distances of hundreds of miles. One project in West Virginia, lists distances of 55 miles, 90 miles, 145 miles, and 175 miles when tallying the amount of transport to different types of mills in order to use all of the timber harvested from the treatment site. Farther west, the figures are similar – a project in Idaho faced transport distances of 125 miles to the nearest pulp and saw mills, the nearest mill to a project in Oregon is 100 miles away, and a California project uses two different mills that are 50 miles from the forest site. The combination of saw mill closings that force loggers to transport biomass farther distances and rising diesel prices squeeze loggers, who are a key element of the biomass energy industry. In an editorial for the newsletter "Northern Woodlands," Chuck Wooster notes that rising oil costs affect the smallest scale biomass operations disproportionately –

"There's no real way for the little guy to bring significant quantities of wood to market 'by hand.' To the extent that larger equipment uses fuel more efficiently and that larger operators can purchase fuel in bulk, the rising cost of fuel may be putting the smaller jobbers at an increasing disadvantage." (Northern Woods Blog Entry)

If loggers' increasing costs of harvest are not matched by increasing prices of wood, their incentive to harvest biomass will decrease. In this event, consumers that want biomass as an alternate energy source will lose, and forest communities that have something to provide will lose. To prevent this kind of a market failure from happening, government policy that supports loggers on a community level may be essential to ensure continued production of biomass as an alternate energy source.

It is important for me to note that I began this paper during the peak of 2008 oil prices, when oil cost \$131.22 per barrel. (Data from the OPEC website) At present, oil costs \$42.54 per barrel. This is, to put it mildly, a huge drop in price, and it may have an extensive impact on short-term expectations of oil prices. It will be important to remember that oil prices can be

volatile, and to emphasize investment in renewable energies as a precautionary measure and in integral feature of energy policy.

Policy Recommendations

There are two components to any policy recommendations for promoting the use of energy from renewable resources. First, the foundation of energy policy must support the use of renewable energy resources. To this end, Martinot et al provide several key recommendations. First, “Policy consistency is essential.” (Martinot, et al, 2004, 24) As Martinot and others note,

“US renewable energy policy has suffered from inconsistency as incentives have been repeatedly enacted for short periods and then suspended. This stop-and-go tendency has seriously hampered the development of markets and industries. As a result, the United States, once the world leader in renewable energy technologies and generation, now lags behind Europe and Japan in many respects.” (Ibid, 24)

There is a strong need to develop renewable energy markets in the United States, since “major renewable energy markets are now overseas, particularly in Europe and Japan.” (Ibid, 24) Even if markets are an imperfect means of promoting the use of sustainable energy or renewable energy sources, US consumers and producers must move in the direction of renewable energy for any endogenous promotion of renewable energy industries. Finally, whether we like it or not, government policy will play a role – Martinot et al can sound like a broken record throughout their paper, but their overriding message that state-level policies have had the greatest impact on promoting renewable energy usage is clear. They argue further that “the impact of these state-level actions is still modest relative to the potential impact of more aggressive federal policy. If anything, US experience illustrates the risk of relying too heavily on state-level support alone.” (Ibid, 25)

Any biomass program will require substantial investment from the government,

“the underlying reality is that biomass energy is expensive to produce, compared to the lower-cost alternatives available on the grid. The high cost of biomass power production, an inevitable result of the small size of the facilities and the high cost of collecting and transporting low-density residue materials, is a considerable liability in a market that is deregulating and increasingly emphasizing cost. The future viability of the enterprise is in doubt.” (Morris, 1999, 22)

In addition to the possible loss of “the amount of environmental and social benefits provided by the [biomass] industry...” jobs will disappear if biomass is dismissed as a viable alternative:

“The loss of the biomass energy industry would represent a loss of almost 12,000 rural employment positions, with serious impacts in affected regions. Many rural communities would also lose their largest source of property taxes, and would suffer other multiplier effects. Energy diversity and security values would be lost.” (Morris, 1999, 22)

Adding to the loss of jobs, Morris argues that “the loss of the U.S. biomass energy industry would exacerbate a number of important environmental problems, and leave affected rural regions with virtually irreplaceable losses of quality employment opportunities and tax base.” (22) It will also be essential to remember the small producers: “Unless a mechanism is developed to compensate biomass generators for the ancillary services they provide, these services will be lost.” (Morris, 1999, 23)

To promote the harvest of biomass, since there appears to be demand for it as an alternative to oil, it is likely that the federal government will need to regulate the biomass industry. A component of this program might be subsidies to local producers – loggers – who are unable to cover their start-up costs in light of decreasing pulp prices. Since consumer demand for biomass appears to decline in relation to waste wood prices, this kind of a subsidy should be linked to a low price for wood. The industry would require significant attention to local logging practices. Unsustainable harvesting practices such as clear-cutting might be a negative consequence of biomass-harvest subsidies, and the appropriate monitor forces should be employed to prevent illicit harvests that damage the environment.

There should be a social component to any job creation program related to harvesting biomass. Clearing small diameter trees, non-native species, or biomass that provides particular fire risks, can require significant human and physical capital. The physical capital for starting a biomass harvesting initiative is also substantial – heavy technology facilitates the work, and knowledge of how to operate the technology is also essential. In regions with large unskilled populations, it may be possible to create biomass harvesting jobs if skilled crews lead unskilled workers, while the workers attend night classes that will enable them to continue the work. Similarly, communities may require low-interest loans or programs that subsidize the purchase of feller-bunchers and other tools essential to efficient harvest of biomass. Any comprehensive policy should address the social and physical costs associated with the biomass market.

If such a program invigorates local forest economies and successfully promotes sustainable harvests, the potential benefits will be wide-ranging. Out west, the risks of forest fire will decrease, and yearly gas emissions will go down. The benefits to wildlife habitats may add to the health of forest ecosystems, and there is a potential for local tourism industries to benefit, as well. Finally, the local satisfaction of being able to generate electricity or heating independent of foreign oil or other unsustainable resources may increase equity and buoy spirits in monetarily intangible ways.

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All of the biomass case studies for Vermont, West Virginia, New Mexico

The Swedish Study

EIA data

OPEC prices per barrel of oil

LA and NH wood pulp prices