The Prospect of Energy Crops in Ohio's Competitive Power Market

Bibhakar Shakya
Ohio Biomass Energy Program
Public Utilities Commission of Ohio
Columbus, Ohio 43214

October, 2000

The Prospect of Energy Crops in Ohio's Competitive Power Market

Bibhakar Shakya
Ohio Biomass Energy Program
Public Utilities Commission of Ohio

Abstract

The restructuring of the nation's $212-billion-a-year electric power industry is moving forward rapidly, state by state, with significant economic and environmental implications. A few states are far ahead in their restructuring movements, while others are just starting. Ohio´s $11 billion electric utility industry is currently progressing toward retail electric competition after the adoption of the electric restructuring legislation in the summer of 1999. Under Ohio's restructuring plan, consumers' electric bills will be unbundled, and the generation portion will be open for competition on January 1, 2001. Ohio consumers will then be able to choose their electric generation company, permitting consumers to save costs on the generation portion of their bills and/or allowing consumers to choose power sources that they consider more environmentally compatible.

Increased competition in the electric generation sector will provide more opportunities for generating electricity using renewable resources such as biomass. The Ohio restructuring legislation includes several environmental provisions which could help spur the growth of renewable energy as consumers become more educated and aware of the competition and environmental impacts of electric generation, as has occurred in other states. The power industry in Ohio is dominated by fossil fuels where about 90% of the total electricity is generated by burning coal.

Ohio has an enormous prospect of developing biomass energy resources such as wood and crop residues, landfill gas, biofuels, and energy crops to meet consumer demand for green power and to mitigate CO_2 emissions. Biomass energy could have a future prospect in Ohio due to the changing electric utility industry, increasing energy demands, international global climate change negotiations, advancements in technology, and federal incentives and requirements. However, current market conditions show that most dedicated energy crops are not economically competitive, although energy crops do provide significant environmental and social benefits beyond simply the financial returns. If these benefits are integrated into the market price, biomass power will potentially become a strong competitor to fossil fuels. Growing international concern on greenhouse gas emissions may enhance the attractiveness of biomass energy. And finally, this paper suggests that adoption of appropriate additional policies for renewable and sustainable energy from successful states may be considered for the development dedicated energy crops in Ohio.

Key Words: electric restructuring, environmental policy, greenhouse gas, green power, energy crops

The Prospect of Energy Crops in Ohio's Competitive Power Market

- *Bibhakar Shakya*

Introduction

Many countries all over the world are restructuring their electric power industry toward market competition and economic efficiency. Similarly, in the U.S., the restructuring of its $212-billion-a-year electric power industry is moving forward rapidly, state by state, with significant economic and environmental implications. A few states are far ahead in their restructuring movements, while others are just starting. Ohio´s $11 billion electric utility industry is currently progressing toward retail electric competition, after the adoption of the electric restructuring legislation in July 1999 (S.B. 3, 1999). Under Ohio's restructuring plan, consumers' electric bills will be unbundled and the generation portion will be open for competition on January 1, 2001. Ohio consumers will then be able to choose their electric generation company to save costs on the generation portion of their bills and/or allowing them to choose power sources that they consider more environmentally compatible.

Increased competition in the electric generation sector will provide more opportunities for generating electricity by using renewable resources such as biomass. The Ohio restructuring legislation includes environmental provisions such as requiring disclosure of environmental characteristics of power supplies on customer bills, as well as net metering of customer generators that use fuels such as solar, wind, biomass, landfill gas, or hydro power, or use a micro turbine or fuel cell. These environmental provisions should help encourage the growth of renewable energy as consumers become more educated and aware of the competition and the environmental impacts of electric generation, as has occurred in other states.

Biomass energy should have a strong future in Ohio due to the changing electric utility industry, increased energy demands, international global climate change negotiations, advancements in technology, and federal incentives and requirements. Ohio has enormous prospects for

developing biomass energy resources such as wood and crop residues, landfill gas, biofuels, and energy crops to meet consumer demand for green power and to mitigate CO_2 emissions.

This paper evaluates major economic, environmental, and policy issues for energy crop prospects in Ohio. The economic viability of energy crop plantations to generate electricity is discussed in conjunction with economic benefits, including the expansion of agricultural markets and strengthening of the Ohio farm economy. Significant environmental benefits of energy crop production include mitigating the greenhouse effect by sequestering carbon, controlling soil erosion and down stream impacts, providing habitats for wildlife, and enhancing bio-diversity. Finally, this paper reviews current federal and state policies and suggests recommendations for the sustainable use of biomass resources in Ohio.

Overview of Potential Energy Crops

Perennial grasses and short-rotation woody crops (SRWC) are considered highly promising crops for energy production. Although Ohio has not established energy crop plantations yet, the most potential crop species suitable for Ohio are switch grass, hybrid poplar, and willow. Switchgrass is a sod-forming, warm season perennial grass which has been established as a part of Tallgrass Prairie for a long time in the native North America (De La Torre Ugarte *et. al.,* 2000; Tolbert and Schiller, 1996). It is known for high yields, adaptability, and suitability to the Midwest Region even in the hot summer months with limited water. Traditionally used as a forage grass along with other Prairie grasses in the region, switchgrass can, therefore, be used as both an energy crop and a forage grass, if needed.

Among short-rotation woody crops, hybrid poplar and willow have shown excellent potential for rapid growth, notable adaptability, and resistance to pests and diseases. Both provide a clean woody biomass feedstock for electricity generation. The perennial nature of these energy crops with high adaptability and disease-pest resistance will increase soil erosion control and reduce chemical applications, particularly in comparison with other row crops. Energy crops are proven to stabilize soil erosion and land degradation, and therefore, can also be grown in marginal and

erodible agricultural lands where row crops generally cannot be grown. Hence, the economic benefits of energy crops also include expansion of agricultural frontier and generation of alternative income sources to local and rural farm communities (De La Torre Ugarte *et. al.,* 2000; Tolbert and Downing, 1996).

Economics Issues

Under current market conditions, most dedicated energy crop plantations are not economically competitive with other cheaply available fossil fuel sources (Graham and Walsh, 1995). However, many biomass-based electricity generation plants have been established and are under construction where the biomass feedstock is cheaply available or incurs disposal costs, such as in wood products and paper industries. Bio-based electric plants have also flourished in the areas where electricity is more expensive than the national average electricity price (Graham *et. al.*, 1996). In Ohio, several paper and wood products industries have more than 25 biomass cogeneration plants, mostly to meet their own energy demand (Shakya, 1996 and 1997), but a few larger ones do sell electricity to utilities (Table 1).

Table 1. Biomass Power Plants in Ohio

Company	Place	Capacity (MW)	Status Year
Hoge Lumber Co.	New Knoxville	3.75	1986
Mead Paper	Chillicothe	10.5	1975
Sauder Woodworking Sawmill	Fulton	7.5	1993
Stone Container Corp.	Coshocton	16.5	1982

Source: Shakya, 1997.

The future of biomass energy seems promising due to numerous benefits beyond simply the financial returns. Energy independence, greenhouse gas mitigation, waste reduction, as well as rural economic development are among the benefits. Several other issues such as unstable fossil fuel prices, advancement in gasification and gas turbine technology, and speedy market development for bio-based co-products (pulp wood or chemicals) could provide substantial support for the future of energy crops (Graham *et. al.*, 1996).

Several research projects around the country are attempting to cut the cost of energy crop production and increase the yield. Decreased production costs and improvements in energy conversion technologies would make energy crops more competitive with other sources of fuels. Potential future policies that reduce greenhouse gas emissions would also make biomass feedstocks more competitive with fossil fuels. In Ohio, this issue will be even more significant, because about 90% of Ohio's total electricity is generated by burning coal (PUCO, 1997). Biomass energy has a significant potential to reduce greenhouse gas emissions in the state.

The current restructuring in Ohio's electric power industry will open up the market for competition. Consumers will be able to choose alternative sources of energy, such as biomass, solar, wind, and geothermal which can be marketed as "green power." Several reports and surveys have indicated that customers have shown a preference and even willingness to pay more for cleaner energy resources (EPRI, 1999; Means, 1999; Mayer *et. al.*, 1999). Although renewable energy development has traditionally been limited by cost considerations, consumers' demand for green-power could open opportunities for energy crops and other renewable energy.

Ohio has enormous prospects for energy crops to meet consumer demand for green power and to mitigate CO_2 emissions. According to the Oak Ridge County-Level Energy Crop database, Ohio has more than 10 million acres of cropland suitable for energy crops (Graham and Walsh, 1999). Energy crops could be grown on some of the land idled by the Conservation Reserve Program (CRP) which was initiated by the US Department of Agriculture under the Conservation Title 1985. The goals of CRP are to retire highly erodible land from crop production for sustaining agricultural production capability; reducing off-site impacts of soil erosion; improving water quality and wildlife habitats; lessening the pressure of market prices of surplus farm commodities; and providing income support to participant farmers (ASCS, 1989). There are more than 36 million acres of land enrolled under CRP in the country and about 300,000 acres in Ohio (USDA, 1997).

Studies have shown that most of these CRP lands tend to revert to row crop production after the ten-year contract is over (Sinner, 1990; Downing *et. al.*, 1995), which will slowly bring back the problems associated with the land prior to CRP. If energy crops become a viable option in Ohio, most of the CRP lands could be used for energy crops without compromising the CRP's environmental benefits (De La Torre Ugarte *et. al.,* 2000; Downing *et. al.*, 1995; Graham *et. al.*, 1996), and in addition, it could potentially increase farm income. Walsh *et. al.* (1996) suggest that using CRP land for energy crops will result in a potential win-win situation for the government, farmers, and the society as a whole.

If the existing idled lands are not used for energy crops, energy crops will have to compete with existing row crops and pastures for land. This may affect the price of food commodities due to shifting in cropland use. Raneses *et. al.* (1998) suggest that a $1 - 4 billion demand for energy crops may result in 2-12% impact on farm sector prices when idle crop land is not available. This impact will need to be taken into consideration if demand for energy crops grows beyond the growth potential of the idled lands and competes with lands for row crops and pastures.

Environmental Issues

Energy crops can provide significant environmental and social benefits. These benefits could veritably lead biomass energy into its economic viability and extend positive impacts in the rural communities. Several research studies have shown that compared to row crops, energy crops may improve soil quality due to reduced erosion and increased nutrients and soil organic matter retention, improve water quality by reducing runoff, and decrease the use of chemicals and fertilizers (Tolbert and Downing, 1995; Tolbert and Schiller, 1996; US Congress, 1993). Energy crops can also be grown in less productive and more erosive lands as compared to conventional row crops, giving rural farm communities a potential new opportunity to diversify the economic base and complement their income (Downing *et. al.*, 1995). Income from energy crops to farmers will be more dependable, as energy crops are more tolerant to harsh weather conditions than food crops. Once the market for energy crops is established, it will remain stable and strong as biomass power plants would need a steady supply of biomass feedstock. Hence, farmers will

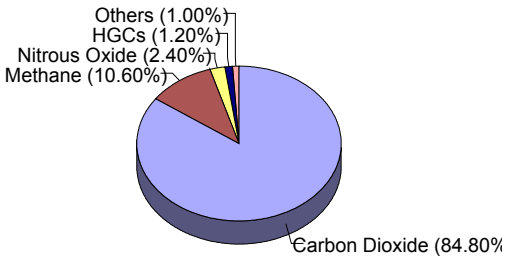
be less affected by the fluctuating commodity food prices. Finally, energy crops can also provide a habitat for wildlife and achieve most of the goals set by the Conservation Reserve Program of the U. S. Department of Agriculture.

Generating electricity from biomass feedstock is an emerging renewable energy technology. Several power projects from energy crops are already underway around the country. Biomass energy has almost no net CO_2 emissions, as CO_2 is sequestered from the environment during the growth stage. Mann and Spath (1998) found in their life cycle assessment that producing electricity from biomass has a 95% closure, with 100% representing total recycle or zero addition of CO_2 to the atmosphere. In addition, biomass fuels produce virtually no sulfur emissions, which will help mitigate acid rain (Bain *et. al.*, 1996; Perlack *et. al.*, 1996). Biomass power plants produce less ash than coal power plants. The ash from biomass plants can be recycled in agricultural lands, assisting in ash disposal costs and helping landfills (Shakya, 1996).

Greenhouse gas (GHG) emission reduction is one of the major environmental issues for sustainable development in the 21st century, especially as international negotiations continue over the 1997 Kyoto Protocol on global climate change. Carbon dioxide (CO_2) is the major component of GHG which contributes about 85% of the total GHG emissions (Graph 1). The 1997 Kyoto Protocol calls on the US to decrease its emissions of greenhouse gases to 7% below 1990 levels by 2012. This calls for an exceptional effort, considering that the US was 11% above its 1990 level at the end of 1998. To reach such a goal, the electric utility industry will need to significantly lower its CO_2 emissions since the burning of fossil fuels is the largest source of CO_2 emissions in the US. The electric utility industry is responsible for 26.2% of the nation's total CO_2 emissions (Graph 2).

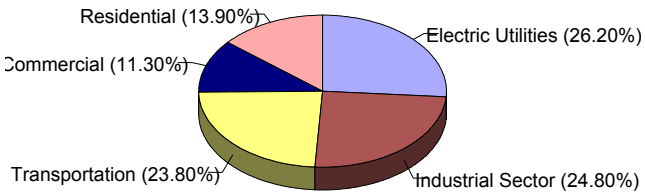
CO_2 from the power sector is one of the major sources of greenhouse gas emissions in Ohio as well. Energy crops represent a promising possibility to make positive impact on the CO_2 emission level of Ohio's electricity generation. Electricity production from biomass feedstocks

could serve as one of the solutions to reduce the greenhouse gas emissions defined in the Kyoto Protocol.



Graph 1. Total US Greenhouse Gas Emissions

Source: DOE, 1994.



Graph 2. Total US CO_2 Emissions

Source: DOE, 1994.

Policy Issues

Ohio is the third largest consumer of fossil fuels after Texas and California (DOE, 1994). As many other states in the country, Ohio's $11 billion electric utility industry is expeditiously moving toward retail market competition since the electric industry restructuring legislation was signed into law by Governor Bob Taft on July 6, 1999 (SB3, 1999). Under this law, Ohio consumers will be able to choose among electricity suppliers from January 1, 2001, the starting date of competitive retail electric service, which may spur the development of a "green power" market in the state. Traditional electric utility service in Ohio provided by eight investor-owned electric utilities, 27 rural electric cooperatives, and 83 municipally-owned power systems operating in the state have not included significant renewable energy resources, beyond a small

number of licensed hydro-power plants.

Nationwide, various levels of renewable energy development programs have been adopted by each individual state under its own electric industry restructuring laws and rules. The most aggressive programs include renewable portfolio standard, system benefit charge, net metering, public benefits funding, shopping credit, information disclosure, and/or consumer education. The Ohio legislature opted neither to directly fund development of renewable energy resources nor to prescribe levels of renewable sources offered by energy suppliers. However, Ohio's restructuring law does include three key environmental provisions which can assist in the growth of the renewable power generation, including biomass energy, in the state. These are:

1. Environmental Disclosure (Ohio Revised Code Section 4928.10): The law states: "The rules shall include requirements for determination of the approximate generation resource mix and environmental characteristics of the power supplies and disclosure to the customer prior to the customer entering into a contract to purchase and four times per year under the contract. The rules also shall require that the electric utility, electric services company, electric cooperative, or governmental aggregator provide, or cause its billing and collection agent to provide, a customer with standardized information comparing the projected, with the actual and verifiable, resource mix and environmental characteristics. This disclosure shall occur not less than annually or not less than once during the contract period if the contract period is less than one year, and prior to any renewal of a contract."

2. Energy Efficiency Revolving Loan Fund (Sections 4928.01(A)(25) and 4928.61 to 4928.63): The loan fund will provide financial assistance for energy efficiency projects and will be administered by the Director of the Department of Development. It will use a temporary rider on retail electric distribution service rates, and is capped at $100 million over a ten-year period. Projects may include "any small-scale renewable project." The law describes the types of projects to be funded:

A. The project will include an investment in products, technologies, or services, including

energy efficiency for low-income housing, for residential, small commercial and small industrial business, local government, educational institution, nonprofit entity, or agricultural customers of an electric distribution utility in this state or a participating municipal electric utility or electric cooperative in this state.

B. The project will improve energy efficiency in a cost-efficient manner by using both the most appropriate national, federal, or other standards for products as determined by the director, and the best practices for use of technology, products, or services in the context of the total facility or building.

C. The project will benefit the economic and environmental welfare of the citizens of this state.

D. The receipt of financial assistance is a major factor in the applicant's decision to proceed with or invest in the project.

3. **Net metering standards (Section 4928.67):** The Ohio law defines net metering as "measuring the difference in an applicable billing period between the electricity supplied by an electric service provider and the electricity generated by a customer-generator which is fed back to the electric service provider." Retail electric service providers must develop standard contracts or tariffs for net metering, and the program is capped when the total rated generating capacity used by customer-generators is less than 1% of a provider's aggregate customer peak demand in the state. The law further defines a "net metering system" as "a facility for the production of electrical energy that does all of the following: (a) uses as its fuel either solar, wind, biomass, landfill gas, or hydro power, or uses a micro turbine or a fuel cell; (b) is located on a customer-generator's premises; (c) operates in parallel with the electric utility's transmission and distribution facilities; (d) is intended primarily to offset part or all of the customer-generator's requirements for electricity."

In addition to these environmental provisions, the Ohio Electric Restructuring Act of 1999 directs the state's investor-owned electric companies to spend up to $16 million for statewide and local consumer education programs prior to and during the first year of electric competition. The law provides an additional $17 million to education programs for the reminder of the

transition period. The Public Utilities Commission, in consultation with the Consumers' Counsel and with other state agencies, will prescribe and adopt by order a general plan by which each electric utility shall provide during its market development period consumer education on electric restructuring (Section 4928.42, SB3, 1999). PUCO chairman Alan Schriber has expressed that "effective consumer education is a vital component in making electric restructuring successful in Ohio" (PUCO, 2000). This education program will help consumers make educated and informed choices about their electric service in the future, which could have a favorable impact on cleaner sources of energy such as biomass power.

Such environmental provisions serve to create an awareness among consumers of the availability of the differing environmental impacts among various energy resources. Thus, environmental provisions can encourage the development of renewable energy sources, such as biomass energy crops, as viable alternative energy options for consumers. While Ohio's measures could spur the market for renewable energy to some extent, Ohio may find it useful to review the most successful renewable energy programs and provisions in other states, which include renewable portfolio standards and shopping credits.

The renewable portfolio standard (RPS) requires a small but growing minimum percentage of the utilities' power supply portfolios to come from renewable sources like solar, wind, geothermal, and biomass. A properly designed RPS would ensure a certain share for renewable energy in the competitive electric market and assist in long-term development of renewable industries. In addition, the shopping credit provides price competition to the consumers who want to switch to any new electric supplier including those providing renewable electricity or biopower.

Currently, the production of renewable energy in Ohio is lower in comparison to some Midwestern states. Lessons from other states and adoption of appropriate policies and programs to encourage renewable sources of energy could place Ohio among states with more aggressive renewable programs and on the path toward a sustainable energy future.

Summary and Conclusion

The environmental provisions of the Ohio legislation, along with other federal incentive programs and market influences could spur development of renewable energy resources in the state, including energy crops. The requirements concerning the disclosure of generation resource mix and environmental characteristics of power supplies, as well as the marketing of green power by electric service suppliers will raise customer awareness of air emissions and other environmental impacts of various electricity resources. Even with a higher price for biopower resources over fossil-fueled power, consumers may choose renewable energy for environmental and social benefits, and allow this premium to be reflected in their energy purchases.

Some survey studies have indicated that customers have a preference and willingness to pay more, if necessary, for cleaner energy resources. Ohio's neighboring state, Pennsylvania, with a similar traditional reliance on coal, nuclear, and gas power sources has shown the country's greatest success in the marketing of green power. Companies offering consumers renewable power options have indicated similar interest in doing business in Ohio. Even traditional utility companies are considering offering environmentally friendly products to consumers. One major utility in the state has recently created a new organization to develop and commercialize emerging renewable energy options and power generation technologies.

According to "North American Renewable Energy Markets," a recent report published by Frost and Sullivan, the total market for renewable energy grew from $204 million in 1998 to $843.4 million in 1999. The report notes that wind power has shown the most growth in recent years but new tax incentives for biopower facilities provide a promising outlook as well. An analyst with the firm further concluded that "currently, coal and natural gas are cheaper than any form of renewable energy. Education about the environmental and social benefits must be integrated with information about pollution and other side effects associated with fossil fuel-based power generation" (RET, 2000).

State officials have begun to recognize the economic development opportunities presented by

renewable energy technologies. The State of Ohio is preparing to implement a pilot project using biodiesel, a blend of diesel and soybean oil, in the state's transportation department vehicles. Biomass resources present an opportunity for Ohio consumers to purchase local resources to promote energy sustainability, rural economic development, and a cleaner environment. Ohio's electric industry restructuring legislation, market forces and customer preferences, and technology development will work in tandem to promote the development and utilization of viable green power alternatives in Ohio and the Great Lakes region.

Ohio's power market shift from a natural monopoly to retail market competition beginning next year may spur the development of renewable energy in the state. However, current market conditions show that most dedicated energy crops are not economically competitive, although energy crops do provide significant environmental and social benefits beyond simply the financial returns. If these benefits are integrated into the market price, biomass power could potentially become a strong competitor in the energy market. Growing international concern about greenhouse gas emissions may enhance the attractiveness of biomass energy. And finally, adoption of appropriate additional policies and programs for renewable and sustainable energy could be considered for the development of dedicated energy crops in Ohio.

References

Bain, R., R. Overend, and K. Craig. May 1996. *Biomass-Fired Power Generation.* Presented at Biomass Usage for Utility and Industrial Power Conference, Engineering Foundation, New York, New York.

De La Torre Ugarte, D., M. Walsh, H. Shapouri, and S. Slinsky. March 2000. *The Economic Impacts of Bioenergy Crop Production in U.S. Agriculture.*

Department of Energy (DOE). April 1992. *Electricity from Biomass.* Solar Thermal and Biomass Power Division. DOE/CH10093-152.

Downing, Mark, Sandy McLaughlin, and Marie Walsh. 1995. "Energy, Economic, and Environmental Implications of Production of Grasses as Biomass Feedstocks." In *Proceedings, Second Biomass Conference of the Americas: Energy, Environment, Agriculture, and Industry.* NREL, Golden, Colorado. 288-297.

Downing, Mark, Marie Walsh, and Sandy McLaughlin. 1995. "Perennial Grasses for Energy

and Conservation: Evaluating Ecological, Agricultural, and Economic Issues." In *Environmental Enhancement through Agriculture: Proceedings of a Conference.* Center for Agriculture, Food, and Environment, Tufts University, Medford, MA.

Graham, R., E. Lichtenberg, V. Roningen, H. Shapori, and M. Walsh. 1996. "The Economics of Biomass Production in the United States." NREL, Golden, Colorado.

Graham, R. and M. Walsh. February 1999. *A National Assessment of Promising Areas for Switchgrass, Hybrid Poplar, or Willow Energy Crop Production.* ORNL - 6944. Environmental Science Division, Oak Ridge, Tennessee.

Graham, R. and M. Walsh. 1995. "Evaluating the Economic Costs, Benefits and Tradeoffs of Dedicated Biomass Energy Systems: The Importance of Scale." In *Proceedings, Second Biomass Conference of the Americas: Energy, Environment, Agriculture, and Industry.* National Renewable Energy Laboratory (NREL), Golden, Colorado. 207-215.

Mann, M. and P. Spath. 1998. "Assessment of the Environmental Implications of Producing Electricity from Biomass." In *Proceedings, Eight BioEnergy Conference: Expanding BioEnergy Partnership.* Madison, Wisconsin. 1220-1228.

Mayer, R., E. Blank, and B. Swezey. July 1999. *The Grassroots are Greener: A Community-Based Approach to Marketing Green Power.* Renewable Energy Policy Project. Special Report. Washington, D.C.

Means, R. May 1999. *Evaluation of a Proposal for Green Power Price Insurance.* Renewable Energy Policy Project. Special Report. Washington, D.C.

Moulton, Robert J. and Kenneth R. Richards. December 1990. *Costs of Sequestering Carbon Through Tree Planting and Forest Management in the United States.* General Technical Report WO-58. USDA Forest Service, Washington, D.C.

Perlack, R. L. Wright, M. Huston, and W. Schramm. June 1995. *Biomass Fuel from Woody Crops for Electric Power Generation.* ORNL - 6871. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Electric Power Research Institute (EPRI). 1999. *Learn More on Green Power and Green Power Marketing.* Palo Alto, California.

Public Utilities Commission of Ohio (PUCO). April 1999. *Ohio Electricity Statistics 1997.* Columbus, Ohio.

Public Utilities Commission of Ohio (PUCO). March 2, 2000. *News Release* 00-016. Columbus, Ohio.

Renewable Energy Today (RET). June 29, 2000. *Green Energy Thrives After Deregulation*. EIN Publishing, Inc. Alexandria, Virginia.

Raneses, A., K. Hanson, and H. Shapouri. 1998. "Economic Impacts from Shifting Cropland use from Food to Fuel." *Biomass and Bioenergy.* Volume 15(6): 417-422.

SB3 (Amended Substitute Senate Bill 3). July 6, 1999. 123rd General Assembly. Columbus, Ohio.

Shakya, Bibhakar. August 1996. *Utilization of Biomass Energy Resources in Ohio.* Ohio Biomass Energy Program, The Public Utilities Commission of Ohio, Columbus, Ohio.

Shakya, Bibhakar. August 1997. *Directory of Wood Manufacturing Industry of Ohio.* Ohio Biomass Energy Program, The Public Utilities Commission of Ohio, Columbus, Ohio.

Tolbert, V, and M. Downing. 1995. *Environmental Effects of Planting Biomass Crops at Larger Scales on Agricultural Lands.* Proceedings of the 2nd Biomass Conference of the Americas: Energy, Environment, Agriculture, and Industry, Portland, Oregon.

Tolbert, V, and A. Schiller. 1996. *Environmental Enhancement Using Short-Rotation Woody Crops and Perennial Grasses as Alternative Agricultural Crops.* Oak Ridge National Laboratory, Oak Ridge, Tennessee.

US Congress, Office of Technology Assessment. 1993. *Potential Environmental Impacts of Bioenergy Crop Production - Background Paper.* OTA-BP-E-118. US Government Printing Office, Washington, DC.

US Department of Energy. 1994. *Climate Challenge Options Workbook.* Washington, D.C.

Walsh, M., D. Becker, R. Graham. September 1996. "The Conservation Reserve Program as a Means to Subsidize Bioenergy Crop Prices." In Proceedings of *The Seventh National Bioenergy Conference: Partnerships to Develop and Apply Biomass Technologies.* Nashville, Tennessee.