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Potential Impacts of Meeting Renewable Portfolio and Fuel Standards on the Economy of Tennessee

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To the Graduate Council:

I am submitting herewith a thesis written by Kateryna Goychuk entitled "Potential Impacts of Meeting Renewable Portfolio and Fuel Standards on the Economy of Tennessee." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Agricultural Economics.

Kim Jensen, Major Professor

We have read this thesis and recommend its acceptance:

Burton English, Christopher Clark

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Potential Impacts of Meeting Renewable Portfolio and Fuel Standards on the Economy of Tennessee

A Thesis

Presented for the

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Degree

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Kateryna Goychuk

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Finally, this manuscript is dedicated to my family: my parents, my brother, and most of all, to my grandfather, who has always been an inspiration to me.

ABSTRACT

The primary objective of this study was to estimate how adopting a Renewable Portfolio (RPS) and Renewable Fuel Standards (RFS) would impact the economy of the State of Tennessee. This was accomplished by 1) developing representative state level RPS and RFS scenarios, 2) projecting Tennessee's renewable energy capacity requirements under these scenarios, 3) identifying representative technologies and associated costs for renewable energy generation, and 4) evaluating decreases in economic activity in non-renewable technologies, such as coal or petroleum, in the state. The economic (output, employment, value-added) impacts were obtained using the IMPLAN, input-output model. Results showed that under the assumptions made, the largest total output and value-added impacts on the Tennessee's economy among five scenarios was the scenario which included electricity generation from such renewable resources as biomass, wind, solar, landfill gas, wastewater gas, biodiesel, and animal waste. The purchase of renewable energy credits was also accounted for in this scenario. For this scenario, total output annual operating impacts were equal to $1.6 billion; total output investment impacts accounted for $1.4 billion. For total value added, total annual operating impacts were equal to 931 million dollars; total value added investment impacts were equal to 651 million dollars. For the RFS scenario, the sum of total output annual operating impacts was equal to 351 million dollars, and total output investment impacts were 170 million dollars. For total value added, total annual operating impacts were equal to 137 million dollars, and total value added investment impacts were equal to 81 million dollars. The largest impacts on the economy under RFS scenario included those from an ethanol facility.

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Chapter 1

INTRODUCTION

Renewable resources have become popular over the last few decades due to the number of potential benefits they provide. Their use has lower negative impacts on the environment than the use of fossil fuels through reduced greenhouse emissions, and thermal, waste and noise pollution. As a result, energy generation from renewable sources helps avoid the environmental costs that occur while using fossil sources. Additionally, the use of renewables leads to improved energy security and fuel diversity.

Renewables can also be an important source of economic benefits through additional employment and investment in innovative technologies. As an example, Madsen et al. (2002) state that "wind power could provide 70% more one-year jobs and more than three times as many permanent jobs as natural gas over a 20-year time framework". Jobs created directly by renewable technologies are in design, production, installation and operation systems (Center for Electric Power, Tennessee Technological University, 1999). Moreover, renewables can increase revenues for local landowners as well as contribute heavily to local tax collections.

Though there are many potential benefits from using renewable energy, there are some problems that may slow down its adoption, mainly cost concerns. Although the price of renewable sources has been decreasing, in most cases it is still cheaper to produce electricity from fossil fuels. Undeveloped infrastructure, which increases the up-front costs of using renewables, and lack of new technologies that are needed to achieve economies of scale are also impediments to adoption. Voluntary adoption programs may

also suffer from the "free-rider" problem. Finally, a lack of information may result in a lack of incentives for producers to use renewables. One possible solution to these problems is the creation of reliable and understandable legislation that will reduce uncertainty and risks, and encourage producers to use renewable energy sources.

1.1 Renewable Portfolio Standard

One of the examples of such legislation is a Renewable Portfolio Standard (RPS) - a market-oriented policy instrument that requires retail electricity suppliers (or electricity generators) to supply a minimum percentage of the amount of their load with eligible sources of renewable energy (EIA, 2003; Wiser et al., 2001).

The term "renewable energy" implies "energy generated from solar, wind, biomass, landfill gas, ocean (including tidal, wave, current, and thermal), geothermal, municipal solid waste, or new hydroelectric generation capacity achieved from increased efficiency or additions of new capacity at an existing hydroelectric project" (U.S. Department of Energy, February 2005). Qualifying renewable facilities are those that are placed in service on or after January, 1, 2002 (EIA, 2002). The amount of energy that is expected to be produced from renewables under RPS is calculated by "multiplying the generation base (which is equal to total electricity retail sales minus renewable generation and small utility sales) by the required share" (EIA, 2003).

In order to meet its RPS requirements a utility may either produce the required amount of renewable electricity on its own, or buy tradable renewable energy credits (RECs), which are a sum of non-energy attributes (environment, economic and social) that are associated with renewable electricity generation. RECs are presented in the form of a document that claims that a given amount of electricity was generated from

renewable sources and are measured in the same units as electricity, usually in megawatt-hours (MWh). Renewable certificates may be either created any time when electricity is generated from renewable sources (for example, this approach is used in Texas and Arizona) or, like in Wisconsin, RECs are created only when a utility generates more renewable electricity than it is required under RPS (Berry, 2004).

RPS have both advantages and disadvantages. An advantage is that it can insure a known quantity of renewable electricity to be produced and consumed. It can also encourage competition among producers that use renewables and consequently lower the price of renewable energy. Finally, it requires a minimum of ongoing administrative involvement (Wiser et al., 2003).

A disadvantage of RPS is that they are necessarily complex, causing difficulties in developing and implementing the RPS. Other disadvantages include lack of perfect knowledge about its cost; lack of experience in its use, and the fact that RPS does not necessarily support diversity among renewable technologies.

These advantages and disadvantages make the decision about implementing RPS a risky venture, especially when experiences in several states have shown that a poorly developed RPS does little to improve generation of renewable energy and can doom an RPS to almost certain failure (Rader, 2001; Wiser et al., 2001).

Currently, 23 states and District of Columbia have an RPS with Texas and California being the largest markets for renewable energy growth; two states - Illinois and Vermont have set voluntary goals in adoption of renewable energy production (U.S. Department of Energy, 2007). The summary of the states' RPS is given in the Table B.1 of the Appendix B

1.2 Renewable Fuel Standard

Another example of legislation is the Renewable Fuel Standard (RFS) – a requirement that a minimum percentage of the volume of gasoline sold or dispensed to consumers would come from renewable fuel. For the first time, a national RFS program was announced in 2005 requiring that in 2006 2.78 percent of the gasoline sold to U.S. consumers would come from renewable sources. Compliance with the RFS in 2006 was determined on a collective basis. The liable parties included refiners, importers, and blenders. Starting from 2007, the United States Environmental Protection Agency (EPA) has proposed a long-term RFS program. It will determine the applicable RFS requirements and liable parties for each following year. However, the minimal requirement for renewable fuels would not be less than 7.5 billion gallons by 2012. If the requirement is not met in the previous year it will be applied to the following year (EPA, 2006).

The term "renewable fuel" implies fuel that is produced from animal or plant products, or wastes. It includes cellulosic biomass ethanol, waste-derived ethanol, biodiesel, and any blending components derived from renewable fuel (EPA, 2006). Under Section 211(o)(4) of the Clean Air Act one gallon of cellulosic biomass ethanol or waste-derived ethanol will be counted as 2.5 gallons of renewable fuel. One gallon of biodiesel will be counted as one gallon of renewable fuel.

Like RPS, an RFS may also allow a credit trading system to comply with the program requirements. However, it is still under construction by EPA. More generally, since RFS is a new policy, it will require more work on a variety of implementation

issues, which may change the parties included, amount of renewable fuels production, credit trading system, and so force.

Currently eight states have adopted an RFS – Hawaii, Montana, Minnesota, Washington, California, Iowa, Idaho, and Louisiana; 5 states are still waiting on the adoption – Illinois, Colorado, Kansas, Missouri, New Mexico. A more detailed summary of states' RFS is presented in the Table B.2 of the Appendix B.

1.3 Situation in Tennessee

Tennessee, according to the U.S. Department of Energy, has high biomass potential and may also have sufficient resources for the use of large-scale wind turbines. Additionally, Tennessee has good hydropower resources as well as good conditions in the western part of the state for establishing solar flat-plate collectors. However, currently of the total state electricity generation of 97,117,165 megawatt-hours only 0.58% comes from non-hydro renewable sources (EIA, 2005), which is less by 0.32% than renewable electricity generation in 2003. Coal remains the main source for electricity production in Tennessee as seen in Table 1.

Renewables that are currently used for electricity production in Tennessee include conventional hydroelectric, landfill gas, wastewater, solar, wind, wood/wood waste, and biomass. In 2004, gasoline consumption in Tennessee was 1,073,800 gallons per day and distillate fuel consumption was 504,600 million gallons per day (EIA, 2005). There is one ethanol producer in Tennessee - Tate & Lyle Company (Loudon), and two companies that produce biodiesel – Agri-Energy, Inc (Louisburg) with an annual maximal production capacity of 5 million gallons, and NuOil (Counce) with annual maximal production capacity of 1.5 million gallons.

Table 1. Electric Power Industry Generation in Tennessee by Energy Source.

Energy Source	MWh	Percentage share
Coal	59,277,469	61.04
Petroleum	230,527	0.24
Natural Gas	535,570	0.55
Other Gases	0	0.00
Nuclear	27,803,108	28.63
Hydroelectric	9,309,541	9.59
Other renewables	558,000	0.58
Pumped storage	-567,935	-0.62
Other	0	0.00
Total electric industry	97,117,165	100.00

Source: Energy Information Administration, 2005

At this stage when both RPS and RFS are relatively new policies, it is important to make projections of the future results of their implementation; to evaluate their potential impacts on the economy and environment for a particular state and the whole country; to identify the factors that have the most influence on policies' results; and to use this experience and knowledge to increase the effectiveness of both RPS and RFS in the states that already have them and design the most beneficial scenarios for those states that still have not accepted RPS and/or RFS.

Currently, Tennessee has no state RPS in place. Also, there is no state level RFS. Therefore, the information on how implementation of an RPS and/or RFS might impact the state's economy would be helpful as the state considers its future energy policy options.

1.4 Objectives

Therefore, the objectives of this study are to identify typical or representative state level RPS and RFS, and obtain estimates of how adopting an RPS and RFS would impact the economy of the State of Tennessee.

Chapter 2

RELATED LITERATURE

Each state's RPS is shaped by a variety of regional factors, such as renewable resource potential, electricity market characteristics, costs, political climate, etc. That is why there is a high level of variability of RPS' details among the states. At the same time, there are some common features that are present in every RPS: targets, timing, definition of eligible resources, scope of geographic eligibility, compliance and flexibility mechanisms, administrative duties, and ways of enforcement.

Targets and timing. Most states set percentage goals to be achieved while some states, such as Iowa, Minnesota and Texas, established their goals in energy units, i.e. in MWh. The target level is usually based on a cost/benefit analysis, however, political viability is also an important determinant of state RPS target level. Usually when RPS includes existing renewable generation, the target level begins at the level that is close to the current level of renewable electricity generation; while in those instances in which the RPS includes only new renewable electricity generation, the percentage target begins at a very low level (Grace et al., 2003). This distinction is one of the reasons why RPS percentage targets may differ significantly among the states.

The percentage targets and time frames are usually not stable, but rather increase over time to give producers intermediate goals to meet. For example, Rhode Island's RPS projects an achievement of 16% of electricity from renewable sources by 2019, but is a graduated requirement until that date; 3% by the end of 2007; 5% between 2008 and

2014; and increasing by 1.5% per year from 2015 to 2019 (Apollo Alliance for Good Jobs and Clean Energy, 2003).

Resource eligibility. The choice of renewables depends on which of the following policy goals the state is trying to achieve: improving resource diversity, economic development, environmental benefits, advancing technologies and/or satisfying public preferences (Rader et al., 2001). Some resources are universally accepted as renewable, such as solar and wind energy; while other sources need to meet certain criteria in order to be considered eligible. One of the latter is hydro electricity. Most of the states consider it ineligible for meeting RPS requirement because of its technological maturity, extensive development and potential environmental problems. However, in some states, e.g, Texas, New Mexico, and Maine it is accepted.

As Hamrin et al. (2006) state, some state RPS are "technology neutral", while some require a share of the renewable energy to come from specific technologies, e.g., Arizona's and Nevada's RPS favor solar energy, while Minnesota emphasizes the use of wind energy and biomass. One of the ways to require retail sellers to meet a certain fraction of the RPS requirements with particular resources is to establish resource tiers. The first tier (or class) includes the requirements for the most preferred resources, while the second tier (class) includes an obligation with a larger group of eligible resources. For example, the RPS in District of Columbia has two tiers. The first tier includes solar, wind, qualifying biomass, landfill gas, geothermal, ocean and fuel cells, while the second tier includes hydro electricity and municipal solid waste (U.S. Department of Energy, 2007).

Scope of geographic eligibility. Geographic eligibility means that the RPS defines the geographic area in which renewable electricity production may occur. For example, some states allow only in-state renewable electricity generation and RECs trading while other RPS allow the purchase of RECs from outside the state.

The advantage of in-state electricity generation is that it leads to more renewable development and improved environment quality for the state. On the other hand, out-of-state TRECs decrease electricity costs as well as reduce RPS compliance costs (Boyce et al., 2004).

As a result, states that already have RPS differ in their opinions about out-of-state RECs trade; Hawaii, Minnesota and Arizona allow only in-state trading, while Connecticut, DC and Maryland accept out-of-state TRECs. Other options include "in-state interconnection" when a state requires that TRECs will be delivered to the state with electricity, or that the "first point of interconnection for the facility will be within the state" (Pollak, 2005). Regionally based TRECs trade is also considered in some states. One of the examples of such regional system is NEPOOL - The New England Power Pool that provides the region's generation and transmission system for six states – Massachusetts, Connecticut, Maine, Rhode Island, New Hampshire, and Vermont (Pollak, 2005). Such regional cooperation allows more flexibility to fulfill RPS policies in different states.

Compliance and flexibility mechanisms. The obligation to comply with an RPS can be placed on retail sellers, default suppliers, or self-generators. Usually RPS are focused on the investor-owned utility companies and are implemented by public utility commissions (Grace et al., 2003).

There are two options by which electricity suppliers may comply with RPS requirements: to own a renewable electricity generator that is eligible under RPS requirement or buy TRECs, which are the most often used flexible mechanism. Other flexibility mechanisms include true-up period and credit banking (Rader et al., 2001).

Means of enforcement. Hamrin (2006) states that enforcement policy should be clearly stated and assigned to a particular agency (usually to the public utilities commission). If electricity producers do not expect strong enforcement, most likely they will ignore RPS requirements.

There are several types of penalties that may be used: monetary penalties and make-up penalties (Rader et al., 2001). One of the requirements for the non-compliance monetary penalties is that they should be higher than the cost of compliance and create the environment in which compliance is the least cost option. This will force producers to meet RPS requirements.

Administrative duties. The tasks of the administrative agency are the following: certify generators that are eligible under RPS, verify electricity generation by certified facilities, impose penalties on the generators that did not meet RPS requirements, develop and organize credit system, modify RPS if necessary, and disseminate information on the program to the public (Rader et al., 2001).

Most of the RPS have been implemented in the past few years and their time frame ranges from 10 to 20 years. Therefore, is it hard to definitely evaluate whether they have been successful or not. However, some assessment has already been done.

Wiser et al. (2003) offer 16 RPS evaluation criteria that fall within three main categories: outcome criteria (amount of renewable energy development, full compliance

with RPS policies, reasonable and stable cost impacts), policy design criteria (broad applicability, carefully balanced supply-demand condition, sufficient duration and stability of targets, well-defined and stable resource eligibility rules, well-defined and stable treatment of out-of-state resources, credible and effective enforcement, flexible verification mechanisms, adequate compliance flexibility, contracting standards and cost recovery mechanisms for regulated utilities and providers of last resource), and market context criteria (presence of creditworthy long-term power purchases, stable political and regulatory support, and adequate and accessible developable resource potential).

These criteria were used to evaluate the 13 states' RPS policies that were in place in 2003. Under outcome criteria, Texas, Minnesota, and Iowa RPS were rated most highly due to meeting all four of the outcome-based criteria. Connecticut, Maine, and Pennsylvania were rated the lowest, since their RPS have had little or no impact on the renewable energy markets.

Texas. In the environment when RPS policies are still considered to be risky ventures, Texas' RPS proved that "a well-crafted and implemented RPS can deliver on its promise of strong and cost-effective support for renewable energy" (Wiser et al., 2001). Ranking second in the US for wind potential, Texas took a full advantage of it with the help of the RPS. In 1999, the first version of Texas' RPS was accepted with the requirement of 2,000 MW of renewable energy to be generated from the renewable sources. However, in 2005 Texas' annual renewable generation schedule was already ahead of its goal by 1,200 MW. A new RPS was implemented requiring the generation at 5,000 MW per year by 2015, with the goal of 10,000 MW of renewable electricity by 2025. The analysis of costs and benefits of the Texas' RPS conducted by the Union of

Concerned Scientists (2005) using the Energy Information Administration's (EIA) National Energy Modeling System projects that by 2020, the 20 percent standard would provide $9.1 billion in total energy bill savings, $1.0 billion in new capital investment, and $1.3 billion in income to farmers, ranchers, and rural landowners from wind power leases. Additionally, the 20% RPS is expected to create 48,810 new jobs.

Ryan Wiser et al. (2001) state some reasons for the success of the Texas RPS, which may be a useful example for other states' policies. Among others it includes clear and predictable long-term targets, strong and automatic enforcement, a well designed RECs system, and the applicability of purchase requirements to almost all suppliers.

Iowa and Minnesota have also been successful in meeting RPS requirements. A study of the projected impacts of the RPS on Minnesota's electricity prices showed that a 9% RPS would result in the generation of 2,000 MW of wind electricity per year by 2010; savings in the amount of 38 cents per month for a typical residential customer over the long term; as well as in net savings to Minnesota state in amount of up to $760 million. In this study all of the required renewable electricity came from the wind turbines (Wind, 2001).

Wisconsin increased RPS requirements from 2.2% of renewable electricity by 2011 to 10% by 2015. The Union of Concerned Scientist (2005) examined the costs and benefits of increasing Wisconsin's RPS using the Energy Information Administration's (EIA) National Energy Modeling System and projected that it would result in 2,160 additional jobs in manufacturing, construction, operations, maintenance, and other industries, which is 960 more jobs than would be generated in producing an equivalent amount of energy from fossil fuels. Analyses also projected $1.3 billion in new capital

investment, $35 million in form of payments to rural areas that would result from biomass energy production, as well as an additional $80 million in income, and $100 million in gross state product.

Colorado RPS is another example of RPS is focused mainly on wind electricity generation. An analysis of Colorado's RPS (20% by 2020) by the Union of Concerned Scientists (2005) projects creation of 5,870 new jobs in manufacturing, construction, operation and maintenance; $1.3 billion in lower electricity and natural gas bills; $1.7 billion in new capital investment; and $79 million in income to rural landowners and ranchers. Binz (2004) projects that the reduction in residential electricity bill would range from $0.20 to $0.51 per month.

Dismukes (2005) conducted an analysis using the IMPLAN model to examine the economic impacts associated with the proposal to increase New Jersey's RPS from 6.5% to 20% by 2020. In this study, three types of economic impacts were analyzed: economic impacts from proposed changes in rates, net economic impacts from the investment in renewable energy technologies, and net economic impacts from the operating and maintenance (O&M) expenditures associated with renewable energy technologies. The economic impacts from changes in rates were projected to be negative. Under different scenarios total annual output would be reduced from $1.1 billion to $13.5 billion by 2021, estimated annual wages losses are expected to be between $455.8 million and $5.5 billion, while job losses would be in-between 11,720 and 361,183. However, economic impacts from new PRS investment projected positive economic benefits coming from construction, installation and development activities. Under different scenarios up to 137,159 new jobs could be created. Economic impacts of the RPS that are related to

O&M expenditures are also projected to be positive. However, total net economic impacts of the proposed RPS turned out to be negative with a net $879.5 million reduction in output in 2021, and job losses of 12,355.

There are a number of studies that explore the relationship between RPS implementation and employment. Kammen et al. (2004) from the University of California, Berkeley reviewed 13 studies that calculated employment impacts of the renewable industry. Five of the studies used input/output model for the analyses. The results showed that renewable energy production under a 20% RPS by 2020 would generate more jobs than fossil fuel-based energy production. Analysis of the potential 20% RPS by 2020 on US employment by the Union of Concerned Scientists (2005) supports these results: it projects the creation of 350,000 new jobs in manufacturing, construction and O&M, and other industries, which is almost twice more than the number of jobs created in the fossil-fuel based sector. The study by Barkenbus et al. (2006) also showed positive employment impacts of the potential Federal 10% RPS by 2020 on the Tennessee Valley Authority region, i.e. 45,000 of new jobs are expected to be created across the region if the Federal RPS is implemented.

Studies of the cost-effectiveness of RPS for a number of states (Connecticut, Maine, Nevada, Massachusetts, New Jersey and California) showed that the price of electricity increases with imposition of the portfolio standard, and tends to increase more with higher levels of RPS (Palmer and Burtraw, 2005; Chen et al., 2003; Wind, 2001). However, recent studies by EIA found that these price increases would be largely offset by a decrease in gas prices that would result from reduced gas use – "the overall cost and price impacts of an RPS program are driven by the combination of the higher cost spent

on renewables minus any change in costs for other technologies that occurs because of the RPS" (Energy Information Administration, 2002). Palmer and Burtraw (2005) state that with the imposition of RPS, energy generation from both coal and natural gas declines and that gas generation is affected much more than coal generation, i.e. gas generation is 43% lower in 2020 with 20% RPS while coal generation is only 10% lower. Moreover, the same study shows that at the 20% level of the RPS nuclear energy generation drops by 15%. The states that rely heavily on wind as the main source of renewable energy generation expect lower electric bills (Wind, 2001; Binz, 2004).

Renewable Fuel Standard. Since RFS is a new policy and not yet fully designed, the literature on its implementation, impacts, etc. is relatively scarce. The analysis of the RFS implementation on the national level showed that use of E10 (10% ethanol blend) would reduce the retail prices of conventional regular gasoline by 5% and as a result will generate $3.3 billion in savings for consumers (Urbanchuk, 2003). The savings come from two major areas: tax exemptions (currently ethanol receives 51 cents per gallon exemption) and refining, as adding 10% ethanol reduces the amount of gasoline to be refined. EPA projects that RFS implementation will result in the reduction of petroleum consumption of 2.3 to 3.9 billion gallons (2006). Moreover, adoption of RFS will create an additional 234,840 new jobs and add about $200 billion (2005 dollars) to GDP between 2005 and 2012 (Urbanchuk, 2003).

The same analysis showed that increased demand for corn (for ethanol production) and soybeans and soybean oil (for biodiesel production) will have little or no effect on livestock producers, but will have positive impacts for crop farmers. Adoption of RFS as expected will increase corn and soybean prices by 6.6% and 5.4%, respectively. It will

also result in steady growth of grains and oilseeds demand. During the time of RFS implementation net cash farm incomes are projected to increase on average by 6% more than would be the case without RFS.

The studies done by Urbanchuk et al. (2002) on the impacts a new 40 million gallon/year ethanol plant would have on the community in which it is located showed that on an annual basis the plant would generate an additional $19.6 million of household income, create up to 694 new jobs, and increase tax revenues by $1.2 million.

Chapter 3

METHODOLOGY

In order to project the potential impacts of state level RPS and RFS on the state's economy, several steps were required. First, Tennessee's current renewable electricity generation and fuel consumption were estimated. Second, general RPS and RFS scenarios for Tennessee were developed. Third, Tennessee's renewable energy capacity requirements to meet these scenarios with in-state capacity were projected. Fourth, representative technology and associated costs for renewable energy generation, including construction and operating costs, were identified. Fifth, decreases in economic activity in non-renewable technologies, such as coal or petroleum, were examined. Sixth, the economic impacts of meeting the RPS and RFS scenarios using these costs and IMPLAN were projected. The following sections describe the methods used to conduct each step.

3.1 Tennessee's Current Energy Capacity and Use

Data on the total net generation of electricity in Tennessee, as well as net generation from power sector providers, for the year 2005 was taken from the Energy Information Administration website for the year 2005. Net electricity generation in Tennessee in 2005 was equal to 97,117,165 MWh. Net generation by power sector providers was 93,952,000 MWh. Electric power industry generation in Tennessee by energy source showed that currently 61.04% of electricity generation comes from coal, while electricity from renewable sources other than hydroelectric constitutes only 0.58% of total electricity generation and is equal to 558,000 MWh (EIA, 2005). See Table 1.

According to EIA in 2005 refiner sales volume of motor gasoline to end users in Tennessee was equal to 1,073,800 gallons/day or 391,937,000 (1,073,800*365) gallons per year. The refiner sales volume of diesel in Tennessee in 2005 was equal to 504,600 gallons/day or 184,179,000 (504,600*365) gallons per year.

3.2 RPS Scenario Development

There were several steps in the RPS scenario development. First, the duration of the scenarios was estimated based on the version of federal RPS proposed by the U.S. Senate. The year when renewable electricity generation under different scenarios is due would be 2020.

Second, the amount of electricity that would be generated in 2020 as well as its retail price were projected. As mentioned above, in 2005, according to the Energy Information Administration (2005), the net generation of electricity in Tennessee was 97,117,165 MWh, while net generation by power sector providers was 93,952,000 MWh. If this value for net generation in 2005 is used along with growth rates in electricity net generation as projected by EIA (2007), the values in Table 2 for net generation in 2020 are obtained. The average annual growth rate projected by EIA for the Southeastern Electricity Reliability Council for net generation through 2030 is 1.9 percent per year (EIA, 2007). The real price of electricity is projected to decline by .1 percent per year. If the 2005 price is used as the beginning year, then the projections in the right hand column of Table 2 can be obtained. In the current study we add a TVA green power premium that is equal to $0.0267, to the 2005 price of electricity, which results in the price of $0.0901 per kWh. Even though EIA projects real electricity prices to fall, with increased reliance on renewables, the rate of $0.0901/kWh is assumed through 2020.

Table 2. Electric Power Projections for Tennessee.

Year	Total Net Generation	Electric Power Net Generation	Price
	MWh		$/kWh ($2005)
2005	97,117,165	93,952,000	0.0634
2006	98,962,391	95,737,088	0.0633
2007	100,842,677	97,556,093	0.0633
2008	102,758,687	99,409,658	0.0632
2009	104,711,102	101,298,442	0.0631
2010	106,700,613	103,223,112	0.0631
2011	108,727,925	105,184,351	0.0630
2012	110,793,756	107,182,854	0.0630
2013	112,898,837	109,219,328	0.0629
2014	115,043,915	111,294,496	0.0628
2015	117,229,749	113,409,091	0.0628
2016	119,457,115	115,563,864	0.0627
2017	121,726,800	117,759,577	0.0626
2018	124,039,609	119,997,009	0.0626
2019	126,396,361	122,276,952	0.0625
2020	128,797,892	124,600,214	0.0625

Source: Energy Information Administration, December 2004.

Third, three RPS percentage targets were estimated. The first target would equal 5.16 percent of the projected 124,600,214 MWh by 2020 or 6,426,210 MWh of renewable electricity. Of this amount, 558,000 MWh of renewables already exist. If these existing renewables are allowed to be included in the RPS (if current renewable electricity is not accounted for in the scenarios, it should be subtracted from total electric power net generation before scenarios targets are estimated), this would imply an additional 5.9 million MWh of renewable electricity would be required (See Table 3). For the first target, this balance is met by co-firing biomass in the state's coal fired plants. It is projected that if the state's current coal fired capacity were used to co-fire at a rate of 15 percent, a total of 5.9 million MWh could be generated.

The second percentage target is calculated at 8 percent (average 15 percent rate that existing state RPS have been set at minus one standard deviation). At 8 percent, the total MWh of renewable electricity would be equal to 9,968,017 (124,600,214*0.8%). If the 558,000 MWh from existing renewables is subtracted, along with the 5,874,210 MWh that might be derived from co-firing in existing coal facilities, the additional renewable electricity that would be needed would be 3,535,807 MWh. In the first scenario for the 8% target, called 8% Scenario (a), the 3,535,807 MWh is met with renewable energy credits. In the second scenario for the 8% target, called 8% Scenario (b), the 3,535,807 MWh is met with other renewable energy and renewable energy credits. The mix of renewables added includes additional wind, solar, landfill gas, wastewater gas, biodiesel, and animal waste, and was based on the Barkenbus et al. study (2006). This mix provides 1,388,798 MWh of the 3,535,807 MWh, with the balance of 2,147,009 MWh being made up by REC's.

The third percentage target is 10 percent. This target is 12,460,021 MWh. As with the 8 percent target, 6,426,210 MWh would be met with existing renewables or through co-firing in existing facilities. In the first 10 percent scenario (10% Scenario(a)), the additional 6,027,811 MWh is met by purchasing REC's. In the second 10 percent scenario (10% Scenario(b)), 1,607,798 MWh of new renewable MWh are added (additional wind, solar, landfill gas, wastewater gas, biodiesel, and animal wastes), and the balance of 4,420,013 MWh is met by purchasing renewable energy credits.

Another piece of information used in scenario development was the types of renewables that would be used to meet RPS requirements. A study by Barkenbus et al. (2006) considered several types of renewables for an analysis of an RPS in the Tennessee

Valley Authority region. These were solar (0.05% of total renewable electricity generation requirement that equals to 19.7 billion kWh in 2020), wind (11.89%), landfill gas (1.33%), wastewater gas (0.62%), biodiesel (3.55%), animal waste (2.85%), co-firing of biomass (agricultural residues, energy crops, forest residues, mill residues) (49.17%), and incremental hydro (8%). This projected mix of resources is employed in the current study, but with several exceptions. Unlike Barkenbus et al. study (2006) incremental hydropower would not be allowed in the current study, since several RPS scenarios at the federal level have not allowed hydro as a renewable resource. The second assumption is that electricity from co-firing would be equal to 5,874,210 MWh across all scenarios. This number was obtained through 15% displacement of coal (by weight) by biomass in all existing Tennessee coal-fired boilers. There are seven of them: Allen plant in Shelby county, Bull Run plant in Anderson county, Cumberland plant in Stewart county, Gallatin plant in Wilson county, John Sevier plant in Hawkins county, Johnsonville plant in Humphreys county, and Kingston plant in Roane county. 15% displacement of coal (by weight) at all these plants would come to 4,114,464 tons of biomass, and, as a result, will result in generation of 5,874,210 MWh of electricity.

The third assumption is that for 8% (b) scenario only one direct fired 25MW plant with poultry litter as a feedstock would be built in Tennessee, while for meeting 10% (b) scenario two such facilities would be built. For other scenarios the direct fire plants would not be built.

The fourth assumption is that for 8% (b) and 10% (b) scenarios only two 13-million gallons biodiesel facilities would be built. Electricity generation from biodiesel would not occur in other scenarios.

Using all the information provided above, five scenarios were created: 5.16% scenario, two 8% scenarios and two 10% scenarios. A summary of the RPS scenarios are given in Table 3. The total net generation and the generation by type of renewable is shown under each scenario.

The share of electricity generated by each renewable source, including wind, solar, landfill gas, wastewater gas, in 8% (b) and 10% (b) scenarios is taken from Barkenbus et al. study. According to that study, these numbers are a reasonable estimate of how much renewable electricity can be generated from these sources in Tennessee by 2020.

Table 3. Renewable Energy Requirements under Various RPS Scenarios for Tennessee

	RPS Scenario				
	5.16 % scenario	8% Scenario (a)	8% Scenario (b)	10% Scenario (a)	10% Scenario (b)
	MWh Required by 2020				
Total Net Generation from Renewables Required	6,432,210	9,968,017	9,968,017	12,460,021	12,460,021
Existing Renewable MWh	558,000	558,000	558,000	558,000	558,000
Additional Renewable MWh Needed					
Total	5,874,210	9,410,017	9,410,017	11,902,021	11,902,021
Wind			678,400		678,400
Solar			7,674		7,674
Landfill Gas			178,926		178,926
Wastewater Gas			96,798		96,798
Biodiesel			208,000		208,000
Animal Waste			219,000		438,000
Co-fire	5,874,210	5,874,210	5,874,210	5,874,210	5,874,210
Renewable Energy Credits	0	3,535,807	2,147,009	6,027,811	4,420,013

3.3 RFS Scenario Development

The information from RFS that are currently projected and/or enacted in other states was used for the development of RFS for Tennessee. Eight states out of thirteen that already have or considering RFS require that until the due date all gasoline sold in the state contain at least 10% denaturated ethanol by volume (E10). Five states that include biodiesel in their RFS require that until the due date all diesel sold in the state contain at least 2% of biodiesel (B2). More information on the states' RFS may be found in table B.2 of the Appendix B. As a result, these shares of ethanol or biodiesel were chosen for Tennessee. The year when RFS is due in Tennessee is 2012; it is the same as the latest projected year of accomplishing the national RFS as put in place under the Energy Policy Act 2005.

As was mentioned before, EIA states that in 2005 prime supplier sales volumes of motor gasoline to end users in Tennessee were equal to 8,754,200 gallons/day or 3,195,283,000 (8,754,200 *365) gallons per year. The prime supplier sales volumes of diesel in Tennessee in 2005 were equal to 3,308,700 gallons/day or 1,207,675,500 (3,308,700 *365) gallons per year.

The average annual price of motor gasoline for Tennessee in 2005 was equal to $1.79 excluding taxes. The price of number 2 diesel fuel for Midwest region is equal to $1.88 excluding taxes (EIA, 2007).

The average growth rates of motor gasoline and diesel prices to end users projected by EIA for East South Central region (which includes Tennessee) are equal to 0.4% and 0.7% respectively (2007). The growth rates of the consumption of motor gasoline and diesel prices are 0.9% and 1.6% respectively. If these values of motor gasoline and diesel

consumption as well as its prices are used along with the growth rates projected by EIA, the values in Table 4 are obtained.

To obtain the amount of ethanol and biodiesel required under the RFS, the percent of required ethanol and biodiesel consumption was multiplied by the projected total sales of motor gasoline and diesel to end users in 2012. The amount of ethanol that is required under RFS would be equal to 328 million gallons (3,285,831,725*0.10). The required amount of biodiesel to be consumed would be equal to 25 million gallons (1,268,108,898*0.02).

In order to meet RFS requirements in Tennessee, one 48-million gallon ethanol facility is projected to be built in the western part of the state. For biodiesel production one 13-million gallon facility in the western part of the state that uses soybeans as feedstock would be built as well as two 5,000 gallon facilities with yellow grease feedstock would be built in Eastern Tennessee. These assumptions are based on the reasonable estimates of how many renewable fuel facilities my be built in Tennessee by 2012.

Table 4. Motor Gasoline and Diesel Sales to End Users Projections for Tennessee.

Year	Motor Gasoline Sales	Diesel Sales	Price of Motor Gasoline	Price of Diesel
2005	3,195,283,000	1,207,675,500	179.0	188.6
2006	3,208,064,132	1,216,129,229	180.6	191.6
2007	3,220,896,389	1,224,642,133	182.2	194.7
2008	3,233,779,974	1,233,214,628	183.9	197.8
2009	3,246,715,094	1,241,847,130	185.5	201.0
2010	3,259,701,954	1,250,540,060	187.2	204.2
2011	3,272,740,762	1,259,293,841	188.9	207.4
2012	3,285,831,725	1,268,108,898	190.6	210.8

Source: Energy Information Administration, 2006.

The amount of ethanol and biodiesel that is not produced within the state but is required under RFS would be imported from other states. For ethanol this would mean that 280,583,172.5 gallons (328,583,172.5 – 48,000,000) of ethanol would be imported. For biodiesel, this would mean that 12,352,177.96 gallons (25,362,177.96 – 13,000,000 – 5,000*2) of biodiesel would need to be imported into the state.

However, since one gallon of ethanol only equals about 75% of the energy of a gallon of gasoline, actual gasoline replaced in Tennessee would be equal to approximately 246 million gallons (328,583,172.5 gallons*0.75). A gallon of biodiesel contains approximately 121,000 BTUs per gallon, which is 87% of energy that is contained in one gallon of diesel. Therefore, actual diesel replaced in Tennessee would equal to 22 million gallons (25,362,177.96 gallons*0.87).

It is also expected that after 2012-2015, there will be ethanol facilities that use cellulosic residues as feedstock in Tennessee. However, since the duration of RFS examined in this study is only 7 years, these technologies would not be considered here.

3.4 IMPLAN

IMPLAN (Impact Analysis for Planning) is an economic input-output model that estimates the impacts of economic changes made in states, counties, or communities. Originally it was developed by the U.S. Forest Service for land and resource management planning (Minnesota IMPLAN Group, Inc., 1997). Nowadays, the IMPLAN software is distributed by Minnesota Implan Group, Inc. and is used in a variety of industries to estimate the impacts of different economic activities.

The IMPLAN model can be either predictive or descriptive. Descriptive models describe the money transfer among industries and institutions. These models include data

(i.e. total industry output, employment and value-added) at both national and county levels for over 500 production industry sectors in the U.S. economy and are based on the North America Industry Classification Systems (NAICS).

Predictive models are used to predict changes in the economy due to exogenous changes (i.e. changes in consumption or demand) using a set of input-output multipliers. Multipliers estimate three types of impacts: direct impacts are the impacts that result from a direct change in final demand; indirect impacts represent the backward linked effects among suppliers that occur as a result of the direct impacts; and induced impacts are the changes in household income due to the direct and indirect impacts. Together direct, indirect, and induced impacts constitute total impacts.

As a result, there are three types of multipliers in the IMPLAN model: Type I multiplier measures direct and indirect impacts, Type II multiplier measures the direct, indirect and induced effects that are based on the income, and Type SAM multiplier that includes direct, indirect, and induced impacts that based on information in the Social Accounting Matrix. Multipliers may be estimated for both a single county and the whole state.

In order to project the economic impacts of meeting RPS and RFS in Tennessee, new renewable energy sectors were added to the IMPLAN model. This was done in several steps based on the Barkenbus et al. (2006) study. First, representative conversion technologies were estimated for all types of renewable feedstocks that are used in the current study. These feedstocks include wind energy, solar energy, methane from landfill and wastewater facilities, soybeans, yellow grease, biomass (including energy crops, agricultural, forest, and mill residues), corn and animal waste in the form of poultry litter.

Each conversion technology's transaction costs were categorized as investment, operating, depreciating, or byproduct. Investment expenditures included one-time capital spending on a facility, such as land, plant construction, and equipment installation costs. Operating expenses included costs that are associated with continuous operation and maintenance of the facility, i.e. expenditures on feedstocks, machinery repair, electricity, consulting services, etc. Once transaction costs were categorized, they were assigned to IMPLAN Sectors based on the NAICS. Dollars per kWh and dollars per gallon, as well as total industry output, employment, and value-added (employment compensation, proprietary income, and indirect business taxes) were projected for each conversion technology. The discussion of each conversion technology is provided below. In order to develop new production function, gross absorption coefficients, representing "the value of the commodity purchased as inputs by regional industries expressed as a proportion of total dollar outlays for the particular industry" (Holland et al., 2006), were calculated for each representative technology. Together with conversion technology data they were added into the model as a representation of new renewable energy sectors. Based on these new sectors, the economic impacts of meeting RPS and RFS requirements were estimated.

3.5 Representative Technology and Associated Costs for Renewable Energy Generation.

Tennessee's Wind Resource. Wind power is the conversion of the energy of wind for practical purposes, such as the generation of electricity. Most wind electricity is generated by wind turbines. There are two types of wind turbines: horizontal axis turbines and vertical axis turbines.

U.S. Department of Energy (December 2005) states that Tennessee has sufficient resources for the use of large-scale wind turbines. As can be seen by the shaded areas in Figure 1, most of the state's wind energy potential, showing a darker shade on the map, is in the eastern third of the state. Significant wind energy potential, located in the Cumberland and the Appalachian Mountains, ranges from 750 to 2,000 MW of generating capacity with the wind speed of Class 3 and higher (Barkenbus et al., 2006). Currently 3,933 MWh of electricity is generated from wind sources in Tennessee. Tennessee Valley Authority (TVA) owns 18 wind towers in Anderson County, TN (TVA, 2005).

Representative Wind Technology. For the purposes of this study, the representative technology used is a horizontal axis turbine with 1.5 MW of capacity per turbine. The representative facility size is a 10 turbine facility or 15 MW of total capacity per facility. Adjusting for net capacity factor at class 3 winds (30%), the net energy output would be about 1.5 MW per turbine*10 turbines*365 days*24 hours a day*.3 capacity factor adjustment*1000 kW/MW=39,420,000 kWh per year (EPRI, 2004).

The total industry output (TIO) for a representative facility would be $3,551,742 (39,420,000 kWh* $.0901/kWh), where $0.0901 is the sum of an average electricity price in 2005 plus TVA green power premium, that is equal to $0.0267.

A summary of expenditures is provided in Table 5. From Table 5, it can be seen that the investment in the facility totals $22.8 million. Annual operating expenses are $569,000 and depreciation is nearly $1.5 million. Operating expenses average to about $.0144 per kWh.

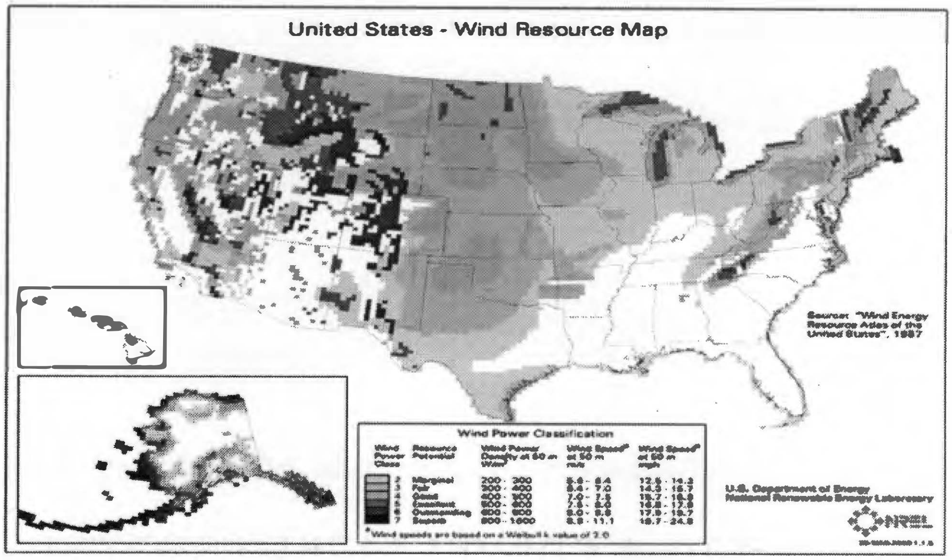

Figure 1. Wind Resource Map of the United States
Source: National Renewable Energy Laboratory, 2006.

A more detailed breakdown of expenditures on investment in facilities and on operating and depreciation is provided in Table A.1 of the Appendix A. The expenditures in the Appendix are based upon cost estimates from EPRI (2004). These cost estimates were then put into 2005 dollars and assigned to the appropriate IMPLAN sectors. The labor estimates are six persons for a 15 MW project. These estimates are based upon IMPLAN power sector estimates and an on Irish Wind Energy Association report of three persons for a 10 MW project (IWEA, 2001).

Wind Energy in the Scenarios. According to the Barkenbus et al. study (2006) wind capacity installed in Tennessee until would be equal to 678,400 MWh (see Table 3) and would be spread among Carter, Johnson, Rhea, Roane, Morgan, and Scott counties. This would require 17 new facilities to be built. Total industry output would be equal to $61,123,840 (17*$3,551,742). The number of employees required statewide would be 103.

Table 5. Expenditure Summary for Representative Horizontal Axis Wind Turbine Power Plant.

Expenditure Type	Expenditures ($, 2005)	Expenditure per kWh ($/kWh)
Investment	22,868,269	0.5801
Operating	569,187	0.0144
Depreciation	1,487,622	0.0377

Source: Electric Power Research Institute & BBF Consult. 2004. "Renewable Energy Technical Assessment Guide – TAG-RE: 2004". Technical Report – 1008366.

Solar Resources in Tennessee. Solar power can be defined as energy that is derived from sunlight for a variety of uses, one of which is generating electricity. There are several technologies that are used to convert solar energy into electricity, such as photovoltaics and three types of concentrating solar power (CSP) technologies (trough systems, dish/engine systems, and power towers). Solar electricity can be also obtained from solar thermal systems; however, they are not applicable for meeting RPS goals because they are "displacing natural gas rather then conventionally generated electricity" (Barkenbus at al., 2006).

The electricity generating solar technology used in this study will be decentralized solar photovoltaics. Such rooftop systems can both provide the owner with electricity and add some electricity into the electricity grid. As can be seen from the darker shades in the Figure 2, Tennessee has very good solar potential in the western part of the state and good potential throughout the rest of the State.

Representative Solar Technology. Using the study conducted by Texas' State Energy Conservation Office, the cost of a PV system for an average household was estimated. For these calculations it was assumed that average electricity consumption by household is equal to 23,239.5 Watt/hour per day or 8.48 MWh per year

(0.023240MWh/day*365). For this amount of electricity and the available sunlight in Tennessee, the needed size of PV array would be equal to 4,733.1 Watt (or 0.00473 MW) and would cost $23,665. The size of the battery bank would be equal to 9683.1 Ampere/hour and would cost $9,683. The cost estimate for an inverter is $4,733. The cost to cover balance of system costs (i.e. fuses, switches, etc.) is estimated to be $7,616. Total estimated PV system cost is $45,698. The cost of installation is about $1.80 per watt (Findsolar.com, 2007). For the given PV system, total installation cost equals $8,519.6 (4733.1 Watt * $1.80).

According to Singh et al. (2001) labor requirements (including installation and O&M services) per MW of PV would be equal to 15,500 hours. Assuming 49 weeks of labor, 40 hours per week, and three weeks of vacation this would result in 8 person-years (15,500 hours/(49*40)). In the current study 905 solar PV panels with total generating capacity of approximately 4 MW (905*0.00473 MW) would be installed. This would result in labor requirements of 32 employees (4MW*8); 20 employees - for installation and 12 – for servicing.

The average annual operation and maintenance cost for a PV system is assumed to be equal to 5-6% of the initial capital cost, or $2,513.4 ($45,698*5.5%). It includes generator service, battery and inverter inspection, as well as overall inspection of the system (Canada et al., 2005). A more detailed breakdown of expenditures is provided in Table A.2 of Appendix A.

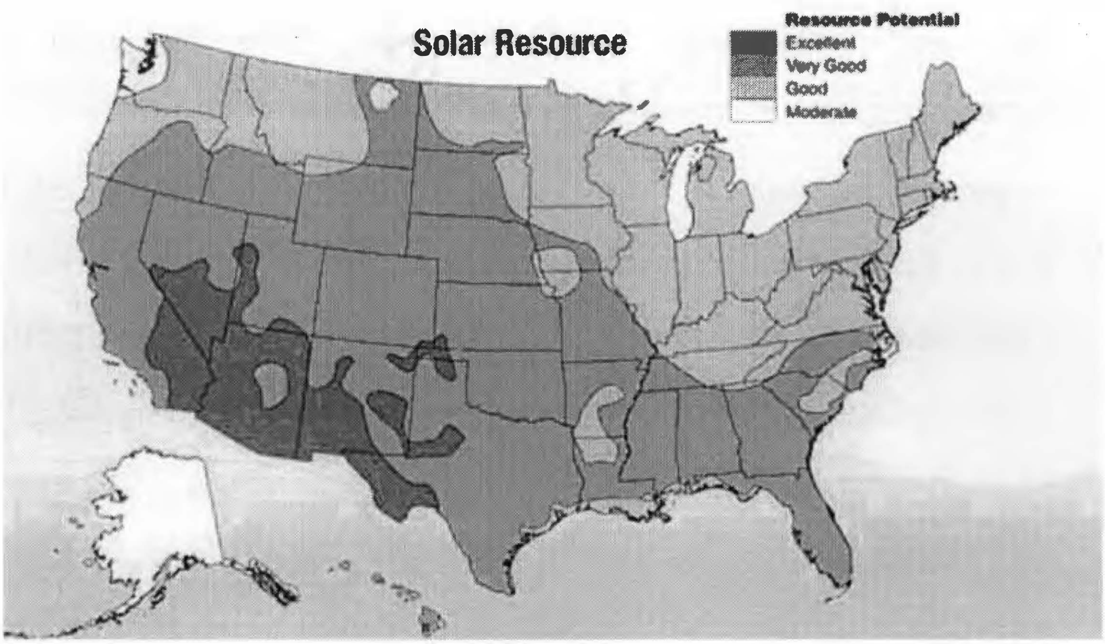

Figure 2. Solar Resource Map of the United States

Source: National Renewable Energy Laboratory, 2007.

Solar Energy in Scenarios. Using the scenarios adopted in this study, the required amount of electricity to be generated from solar energy would be equal to 7,674 MWh for both 8% and 10% scenarios, assuming 15% capacity factor. This would require 905 PV panels (7,674 MWh / 8.48 MWh) to be installed in Tennessee by 2020. Total O&M costs statewide would be equal to $2,273,853 (905*$2,513.4). Total investments across the state would be $49,050,398 (($23,665+$9,683+$4,733+$8,519.57+$7,616)*905). Since this electricity would be generated by households, TIO of the Power Generation and Supply sector would be decreased by $691,427.4 (7,674,000 kWh * $0.0901).

The Energy Policy Act 2005 offers energy tax credit for solar photovoltaics systems in the amount of 30% of the qualified PV system expenditures, but no more than

$2,000. Currently, incentives apply only to PV systems installed during 2006 – 2008. In the current study we account for this tax credit, assuming that it will be extended beyond 2008. Since the total number of PV systems expected to be installed in Tennessee by 2020 is equal to 905, the maximum amount of the tax credit would be $1,810,000 (905*$2,000). In IMPLAN the entire amount of the tax credit was, first, allocated among households with nine income levels, and then its impacts were estimated in the model.

Landfill Gas in Tennessee. Landfill gas is produced by the anaerobic decomposition of organic solid waste. It is collected using a series of wells that concentrate methane in one place. After that it may be used along with natural gas to fuel conventional combustion turbines or small combined cycle turbines. It may be also used in fuel cell technologies to produce electricity. Use of landfill gas for electricity generation reduces the harmful environmental impacts cased by methane release into the atmosphere. Currently Tennessee has seven operational landfill gas projects and twelve candidate landfills for landfill gas projects with the approximate capacity of 34 MW.

Representative Landfill Gas Technology. A representative facility was developed using information from the Landfill Methane Outreach Program, Energy Project Landfill Gas Utilization Software (E-PLUS). The facility capacity is 4,594 kW or 34,457,555 kWh/year. Total industry output for the given facility is $3,104,626 (34,457,555 kWh/year*$.0901). The number of employees is five. A summary of expenditures is provided in Table 6. As shown in Table 6, the investment in the facility totals $7,203,132. Operating expenses are $939,368 and depreciation is nearly $719,313. Operating expenses average to about $0.0273 per kWh.

A more detailed breakdown of expenditures on investment in facilities and on operating and depreciation are provided in Table A.3 of Appendix A. The expenditures in the Appendix are based upon cost estimates from the E-PLUS software of the Landfill Methane Outreach Program (EPA, 2005). From Table A.3 of Appendix A, the largest shares of the investments and depreciation to construct landfill to methane conversion facility are attributed to Motor Vehicle Parts Manufacturing (IC Low Engine and Engineer Wiring Costs) – 28.76%, Other New Construction, such as Electricity Generation Installation, Gas Treatment Installation, Inter Connect Installation and Other Costs – 26.89% and Iron, Steel Pipe and Tube Purchased Steel – 19.96%. While the lowest shares of the investments and depreciation are attributed to Industrial Process Variable Instruments – 0.01%, and Computer System Design Services – 0.4%.

Landfill Gas Energy in the Scenarios. According to the Barkenbus et al. study (2006) landfill gas capacity installed in Tennessee through 2020 would be equal to 178,926 MWh. This would require five new facilities to be built. Total industry output would equal to $16,121,232.60 ($3,104,626*5). The number of employees required statewide would be 25.

Table 6. Expenditure Summary for a Representative Landfill Gas Power Plant.

Expenditure Type	Expenditures ($)	Expenditure per kWh ($/kWh)
Investment	7,203,132	0.2090
Operating	939,368	0.0273
Depreciation	719,313	0.0209

Source: Environmental Protection Agency, Landfill Methane Outreach Program. 2005. Documents, Tools, and Resources. Energy Project Landfill Gas Utilization Software (E-Plus).

Wastewater Gas in Tennessee. Wastewater gas is produced under anaerobic conditions. When wastewater is passed through an anaerobic digester, the bacteria digest the residual solids and create methane as the by-product of this process. This gas is than forwarded to a micro turbine (or engine) for electricity generation.

As can be seen by the shaded areas in Figure 3, most Tennessee counties have less than 100 tons of methane emissions from domestic wastewater treatment per year, though Shelby County has above a thousand tons of methane emissions annually and Davidson County's methane emissions vary between 750 and 1000 tons per year.

Representative Wastewater Gas Technology. A representative facility was developed using information from Utah SLC Public Utilities Department. The facility electricity sales are equal to 12,264,000 kWh/year or 12,264 MWh/year. Total industry output for the given facility is $1,104,986 (12,264,000 kWh/year*$0.0901). The number of employees is 2.6. A summary of expenditures is provided in Table 7. It can be seen that the investments are equal to $2,531,698.59; operating expenses totals $598,167.49 and average to about $0.0488 per kWh.

A more detailed breakdown of expenditures on investment in facilities and on operating and depreciation are provided in Table A.4 of Appendix A. The expenditures in the appendix are based upon cost estimates from Utah SLC Public Utilities Department.

Table 7. Expenditure Summary for Wastewater to Methane Conversion Technology

Expenditure Type	Expenditures ($)	Expenditure per kWh ($/kWh)
Investment	$2,531,698.59	$0.2064
Operating	$598,167.49	$0.0488

Source: Utah SLC Public Utilities Department.

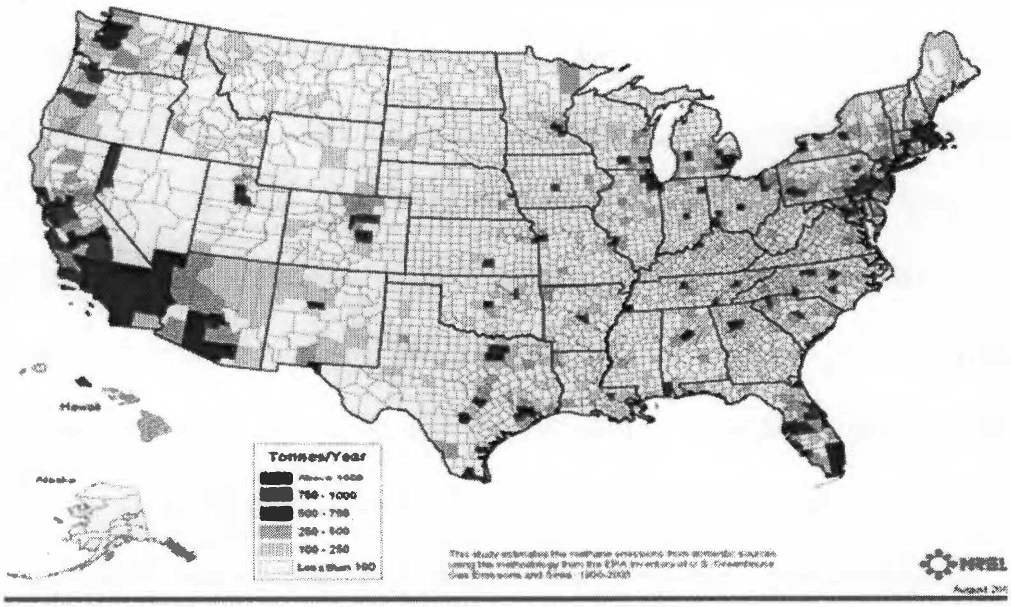

Figure 3. Methane Emissions from Domestic Wastewater Treatment
Source: National Renewable Energy Laboratory, 2005.

Wastewater Gas Energy in the Scenarios. According to the Barkenbus et al. study wastewater gas capacity installed in Tennessee through 2020 would be equal to 96,798 MWh. This would require eight new facilities to be built. Total industry output would be equal to $8,721,499.8 ($1,104,986*8). The number of employees required statewide would be 21.

Biodiesel in Tennessee. Biodiesel is a renewable fuel derived from biological sources, such as vegetable oils, animal fats, and recycled restaurant greases. It is safe, non-toxic, biodegradable, and reduces air pollution. Most of the biodiesel produced is used in the transportation sector, however, it may be also used for electricity generation. Soybean-based biodiesel can be directly used in the new diesel-powered electricity generators (an example of such generator is McMinnville Biodiesel Project in Tennessee) or it can be used in the existing electricity-generating facilities.

Representative Biodiesel Technology. A representative facility was developed using information from a study by English et al. in cooperation with Frazier, Barnes and Associates (2002). The facility size is 13 million gallons/year. Total industry output for the given facility is $48,490,000 (13,000,000 gallons/year*$3.73, where $3.73 is sum of wholesale price of B100 in amount of $2.99 per gallon that was taken from Oil Price Information Service for Minneapolis, MN for 2006 and blender's credit in amount of $1.00 after 2006 price was adjusted back to 2005 price using price index). The number of employees is eighteen. The feedstock required for electricity generation may come both from inside and outside the state. A summary of expenditures is provided in Table 8.

As shown in Table 8, investment in the facility totals $42,430,657. Operating expenses are $73,262,931 and depreciation is nearly $3,562,877. Operating expenses average to about $5.64 per kWh.

A more detailed summary of expenditures on investment in facilities and on operating and depreciation are provided in Table A.5 of Appendix A. The expenditures in this table are based upon cost estimates from English et al. study. From the Table A.5 of Appendix A, the largest share of the investments and depreciation to construct biodiesel from soybeans conversion facility are attributed to Conveyor & Conveying Equipment Manufacturing (Feedstock & Product Storage and Handling) – 31%. The lowest share of investments and depreciation are attributed to Management of Companies & Enterprises, such as Set-up Consulting – 0.015% and to Real Estate (Land) – 0.57%.

Table 8. Expenditure Summary for a Representative Biodiesel from Soybeans Facility

Expenditure Type	Expenditures ($)	Expenditures per gallon, ($/gallon)
Investment	$42,430,657	$3.26
Operating	$73,262,931	$5.64
Depreciation	$3,562,877	$0.27

Source: English, B., K. Jensen, and J. Menard in cooperation with Frazier, Barnes & Associates, Llc. 2002. "Economic Feasibility of Producing Biodiesel in Tennessee".

Biodiesel Energy in the Scenarios. In the current study we assume that in 2020 in Tennessee two 13-million gallons biodiesel facilities will be built. Together they would supply 208,000 MWh (13,000,000 gallons/0.125 gallons per kWh*2) of electricity. Total industry output would be equal to $98,280,000 ($49,140,000*2). The number of employees required statewide would be 36.

Animal Waste in Tennessee. Animal waste refers to manure and bedding materials that are mixed with manure. Renewable electricity is produced from animal waste in the following way: first, manure is collected in a large container. Then it is put through anaerobic digesters that are designed to maximize the methane production from the decomposition of manure. The next step is to pipe methane gas to a co-generation system.

Representative Animal Waste Technology. Since direct combustion of animal waste is not often used due to the air pollution concerns it may cause, a direct wood-fired power plant as a representative technology that uses poultry litter as a feedstock will be used in the current study. This facility was developed using information from the technical report provided by Electric Power Research Institute and BBF Consult.

Table 9. Expenditure Summary for Wood Fired Power Plant

Expenditure Type	Expenditures ($)	Expenditures per kWh ($/kWh)
Investment	$72,149,375.12	$0.329
Operating	$5,978,658.03	$0.027
Depreciation	$3,401,345.72	$0.016

Source: Electric Power Research Institute & BBF Consult. 2004. "Renewable Energy Technical Assessment Guide – TAG-RE: 2004". Technical Report – 1008366.

The facility size is 219,000,000 kWh/year or 219,000 MWh/year. Total industry output for the given facility is $19,731,900 (219,000,000 kWh/year*$0.0901). The required number of employees is 26. A summary of expenditures is provided in Table 9. The investments are equal to $72,149,375.12; operating expenses total $5,978,658.03 and average to about $0.027 per kWh. Depreciation costs equal $3,401,345.72. A more detailed breakdown of expenditures on investment in facilities and on operating and depreciation are provided in Table A.6 of Appendix A.

From Table A.6 of Appendix A, the largest share of the investments and depreciation to construct animal waste to methane conversion facility are attributed to Turbine & Turbine Generator Set Units Manufacturing (Stoker Steam Generator, Steam Turbine/Generator Set) – 25.42%. Large share of investments is also attributed to Management Expenses, such as Home Office, Field Expenses and Contractor Fees – 25.13%. While the lowest share of investments and depreciation are attributed to Construction Machinery Manufacturing (Hammer Mill/Hopper, Dozer 1, & Dozer 2) – 0.03% and 0.06%.

Animal Waste Energy in the Scenarios. As mentioned above, one wood-fire plant would be built for 8% (b) scenario and two such facilities would be built for 10% (b) scenario. In scenario 8% (b) the total TIO statewide would be equal to $19,731,900

(\$19,731,900*1). For scenario 10% (b) the total TIO would be equal to \$39,463,800 (\$19,731,900*2).

Biomass co-fire. Biomass in the form of energy crops, agricultural, forest, and mill residues would be co-fired with coal in existing coal-fired facilities. As mentioned before there are seven steam plants currently operating in Tennessee. At a 15% rate of coal replacement (by weight) it is expected that, in total, these facilities would generate 5,874,210 MWh of renewable electricity from biomass. 4,411,464 tons of coal would be displaced by these biomass materials.

Agricultural residues consist of the biomass materials that remain above the ground after harvesting agricultural crops. They include straw from barley, beans, oats, rice, rye, and wheat, stovers from corn, cotton, sorghum, beans, oats, orchard trimmings and rice straw and husks, as well as sugar cane residue. The moisture content of agricultural residues varies from 8 to 80 percent. The most frequently used crops to collect agricultural residues from are corn and soybeans.

The advantages of using agricultural residues include more value placed on farmers, as well as decreased CO_2 emissions. However, agricultural residues have the lowest energy value among all of the residues, therefore, their use will be limited. Moreover, 60-70% of agricultural residues need to be left on the soil to maintain its quality.

Forest (logging) residues consist mainly of tree branches, tops of trunks, stumps, and leaves that remain on the forest floor after logging operations. Other wood sources may include dead trees, undersized trees, noncommercial tree species that were removed

from woodlots. Forest residues may be used in different forms, i.e. natural form, mechanically, chemically, and biochemically modified forms. They have 10% greater energy value per unit compared to agricultural residues.

Mill residues may be divided into two categories: primary mill residues and secondary mill residues. Primary mill residues consist of wood materials, such as slabs, edgings, trimmings, sawdust, etc., and bark that is generated at manufacturing plants. Secondary mill residues consist of wood scraps and sawdust from furniture factories, pallet mills, as well as wholesale lumberyards. According to National Renewable Energy Laboratory pallet and lumber companies generate about 300 tons/year, while small woodworking companies generate from 5 to 20 tons/year. According to National Renewable Energy Laboratory the estimated amount of secondary mill residues in Tennessee is 75,000 dry tons. Together primary and secondary mill residues constitute 1,632,000 dry tons. In general, mill residues also have relatively high energy value. For example, mill residues have 10% greater BTU value per unit comparing to agricultural residues.

Electricity produced from energy crops, in particular switchgrass, will constitute the highest percentage in meeting RPS requirements for Tennessee. Switchgrass is native to North America. It is easy to grow as it is tolerant to poor soils, flooding or droughts, and is capable of producing high yields with low applications of fertilizers. Its energy value is 5% higher than agricultural residues, but 5% less than forest/mill residues. As Barkenbus et al. study (2006) states, the benefits from using switchgrass for electricity generation include decreased air pollution, reduced farm land erosion, better habitat for animals, as well as increased employment and income inflows in rural areas. Another potential way

to use energy crops is to plant them on environmentally damaged lands, i.e. on closed mining sites.

Representative Biomass Co-Fire Facility. A representative facility was developed using information from the study by English et al., prepared for the Northeast Regional Biomass Program and the United States Department of Energy. The facility size is 137,313,000 kWh/year or 137,313 MWh/year. Total industry output for the given facility is $12,371,901.3 (137,313,000 kWh/year*$0.0901). The number of employees required is seven. A summary of expenditures is provided in Table 10.

As shown in Table 10, investment in the facility totals $4,138,011. Depreciation expenses are $284,849. Operating expenses would vary depending on the feedstock used. For agricultural residues they would be equal to $11,788,405, for forest residues - $21,823,677, for mill residues - $23,223,422, and for energy crops - $132,398,011.

A more detailed breakdown of expenditures on investment, operating and depreciation expenditures is provided in Table A.7 of Appendix A. The expenditures in the Appendix are taken from the English et al. study (2004). From Table A.7, the largest share of the investments and depreciation to construct co-fire facility (with agricultural residues used as feedstock) are attributed to Other New Construction, such as Biomass Handling System Installation, Civil Structural and Electrical – 49.28% and 71.58% respectively. While the lowest share of investments is attributed to Industrial Process Furnace & Oven Manufacturing (Modification at Burners) – 0.82%; the lowest share of depreciation is attributed to Prefabricated Metal Buildings and Components – 0.86%.

Table 10. Expenditure Summary for Co-Fire Plant.

Expenditure Type	Expenditures ($)	Expenditures per kWh ($/kWh)
Investment	$4,138,011	$0.030
Depreciation	$284,849	$0.002

Source: English, B., J. Menard, M. Walsh, and K. Jensen. 2004. "Economic Impacts of Using Alternative Feedstocks in Coal-Fired Plants in the Southeastern United States".

Biomass co-fire in Scenarios. Renewable electricity from biomass co-fire would be accounted for in all scenarios and would equal to 5,874,210 MWh. The total TIO statewide would equal to $529,266,411 (5,874,211,000 kWh*$0.0901).

According to Barkenbus et al. study (2006) co-fire of biomass at 15% rate at all existing coal-fired boilers would replace 4,411,464 tons (or 4,862,807 short tons) of coal. As a result, the TIO reduction to the Coal Mining sector in the state, if 15% co-fire is applied at all coal-fired facilities, would be equal to $26,413,576.24 (4,862,807 short tons *$42.50*0.127806), where $42.50 is the price of one short ton of coal in 2005 in Tennessee (EIA, 2007); and 0.127806 is regional purchase coefficient for the Coal Mining sector. However, if the overall energy demand grows over time, new coal-fired facilities that apply cleaner technologies might be added, which in turn may increase the overall use of coal. We assume that the amount of coal-fired facilities will remain the same, therefore, while accessing impacts in IMPLAN, TIO of Coal Mining sector would be decreased by $26,413,576.24.

Ethanol in Tennessee. Ethanol (or ethyl alcohol) is an alcohol that is obtained through fermentation and distilling simple sugars. Ethanol may be used in pure form (E100) or may be mixed with gasoline in different proportions, i.e. E10, or E85.

Conventional vehicles can use E10. However, the Big Three automakers have begun selling E85 compatible (flex fuel) vehicles on a large scale.

There are different feedstocks that can be used for ethanol production, such as corn, wheat, barley; new technologies also allow ethanol to be made from "cellulosic" feedstocks. In this study the feedstock for the ethanol production plant is corn, because cellulosic technologies introduction may not be commercially profitably within the next 7-8 years. Figure 5 shows that there is one ethanol producer in Tennessee - Tate & Lyle Company, which is located in Loudon (Renewable Fuels Association).

Representative Ethanol Technology. A representative facility was developed using information from the study by McAloon et al. (2000). The facility size is 48 million gallons per year. Total industry output for the given facility is $110,880,000 (48,000,000 gallon/year*$2.31), where $2.31 is a sum of a wholesale price of ethanol taken from EIA Annual Energy Outlook for 2005 and blender's credit which is equal to $0.51 per gallon. The number of employees at the facility is thirty six.

A summary of expenditures is provided in Table 11. As shown in this table, the investment in the facility totals $46,681,481.64. Operating expenses are $83,669,851.47 and depreciation is nearly $4,492,827.44. Operating expenses average to about $1.743 per gallon. A more detailed summary of expenditures on investment in facilities and on operating and depreciation are provided in Table A.8 of Appendix A.

Ethanol in Scenarios. As mentioned above, in order to meet RFS requirements in Tennessee, one 48-million gallon ethanol facility is projected to be built in the western part of the state. Total industry output statewide would be equal to $110,880,000 ($110,880,000 *1).

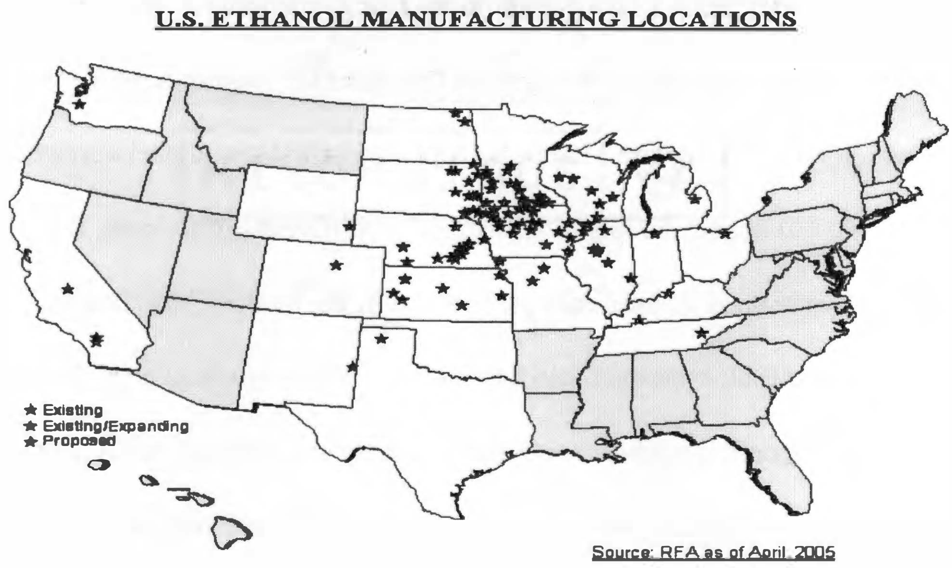

Figure 4. U.S. Ethanol Manufacturing Locations
Source: Renewable Fuels Association, 2005.

Table 11. Expenditure Summary for a Representative Ethanol from Cellulosic Residues Facility.

Expenditure Type	Expenditures ($)	Expenditures per gallon ($/gallon)
Investment	$46,681,481.64	$0.973
Operating	$83,669,851.47	$1.743
Depreciation	$4,492,827.44	$0.094

Source: McAloon, A., F. Taylor, W. Yee, K. Ibsen, and R. Wooley. 2000. "Determining the Cost of Producing Ethanol from Corn Starch and Lignocellulosic Feedstocks". National Renewable Energy Laboratory (NREL/TP-580-28893).

Biodiesel. Biodiesel is a fuel derived from renewable sources, such as vegetable oils, animal fats, or recycled restaurant greases that meet the requirements of the American Society for Testing and Materials (ASTM) D-6751. Biodiesel may be used in the pure form (B100) or may be mixed with diesel in different proportions, i.e. B2, B5. There are some advantages of biodiesel use. For example, biodiesel has higher lubricity index compared to diesel; moreover, biodiesel is a better solvent than petrodiesel. As for the environmental benefits, biodiesel significantly reduces emissions of CO, NOx, hydrocarbons, and particulate matter. Sulfur emissions are also much lower compared to those from petroleum diesel use. As a result biodiesel reduces health risks that are associated with the use of petrodiesel (Biodiesel.org, 2007).

The most used feedstock for biodiesel production is soybean oil. According to the U.S. Department of Agriculture, each bushel of soybeans can create 1.4 gallons of biodiesel fuel. Even though yellow grease is considered to be much less expensive than soybean oil, its supply is limited, and it has uses other than fuel, such as animal feed additive, soap production, etc.

Currently, according to the National Biodiesel Board, there are two companies that produce biodiesel in Tennessee – Agri-Energy, Inc (Louisburg) with an annual maximal production capacity of 5 million gallons, and NuOil (Counce) with an annual maximal production capacity of 1.5 million gallons. The primary feedstock both companies use is soybean oil. Two more biodiesel plants are projected to be constructed in Tennessee, one in Manchester and one in Pulaski.

Representative Biodiesel from Soybeans Technology. A representative facility was developed using information from the study by English et al. in cooperation with Frazier,

Barnes and Associates (2002). The facility size is 13 million gallons/year. TIO for the given facility is $48,490,000 (13,000,000 gallons/year*$3.73, where $3.73 is the sum of the wholesale price of B100 in amount of $2.99 per gallon that was taken from Oil Price Information Service for Minneapolis, MN for 2006 and a blender's credit in the amount of $1.00 after 2006 price was adjusted back to 2005 price using price index). The number of employees is 18. The feedstock required for electricity generation may come from both inside and outside the state. A summary of expenditures is provided in Table 12.

As shown in this table, investment in the facility totals $42,430,657. Operating expenses are $73,262,931 and depreciation is nearly $3,562,877. Operating expenses average to about $5.64 per gallon. A more detailed summary of expenditures on investment in facilities and on operating and depreciation are provided in Table A.5 of Appendix A. It is assumed that for the current study one 13-million gallon facility would be built. Therefore, total TIO statewide would be equal to $48,490,000.

Table 12. Expenditure Summary for a Representative Biodiesel from Soybeans Facility.

Expenditure Type	Expenditures ($)	Expenditures per gallon, ($/gallon)
Investment	$42,430,657	$3.26
Operating	$73,262,931	$5.64
Depreciation	$3,562,877	$0.27

Source: English, B., K. Jensen, and J. Menard in cooperation with Frazier, Barnes & Associates, Llc. 2002. "Economic Feasibility of Producing Biodiesel in Tennessee"

Representative Biodiesel from Yellow Grease Technology. A representative facility was developed based on two studies by Charles Peterson, University of Idaho (2006), and Frazier, Barnes and Associates (2004). The original sizes of the facilities were 0.5 and 0.8 million gallons of biodiesel per year. In order to scale it down to 5,000 gallons per year we calculated investment and operating costs per gallon and multiplied them by 5,000. The percentage distributions of the operating and depreciation expenses for the IMPLAN were taken from the study by Fortenberry, University of Wisconsin-Madison (2005). According to this study the depreciation rate of manufacturing and industrial buildings was 5 percent, while for storage tanks and transesterification machinery was equal to 10 percent. Total industry output for the given facility is $16,150 (5,000 gallons/year* $3.23, where $3.23 is the sum of the wholesale price of B100 in the amount of $2.99 per gallon that was taken from Oil Price Information Service for Minneapolis, MN for 2006 and blender's credit in the amount of $0.50 after 2006 price was adjusted back to 2005 price using price index).

Labor estimates were obtained by scaling down the labor requirements for large biodiesel facilities with the size of 10 million gallons/year, and 30 million gallons a year for a facility of 5,000 gallons a year (Fortenberry, 2005). First, the amount of labor for one gallon was calculated and then was multiplied by 5,000. In both cases the number of employees for a 5,000-gallon facility would be equal to 0.1 employees.

Revenues from by-product (glycerin) were calculated based on the Charles Peterson study (2006). According to this study the value of glycerol of USP value is $0.40 per pound. The amount of glycerin produced at the biodiesel plant with the

capacity of 0.5 million gallons is 0.37 million lbs. After scaling down this amount, a 5,000 gallon biodiesel facility will produce 3700 lbs of glycerin.

A summary of expenditures is provided in Table 13. As it can be seen from this table, investment in the 5,000 gallon facility totals $7,587.50, depreciation costs are equal to $632.81. And operating expenses are equal to $6,232.28 and average to about $1.25 per gallon. For the current study two biodiesel from yellow grease facilities are assumed to be built. Total TIO statewide would be equal to $32,300 ($16,150 *2).

A more detailed summary of expenditures on investment and operating costs are provided in Table A.9 of Appendix A. The largest share of the investment and depreciation to construct biodiesel from yellow grease conversion facility are attributed to Transesterification Machinery – 65.97% of investment costs and 79.04% of depreciation costs. The lowest share of investment is attributed to Permits and miscellaneous – 2.06%; the lowest share of depreciation costs is attributed to Manufacturing and Industrial Buildings – 6.13 %.

Table 13. Expenditure Summary for a Representative Biodiesel from Yellow Grease Facility.

Expenditure Type	Expenditures ($)	Expenditures per gallon, ($/gallon)
Investment	$7,587.50	$1.52
Operating	$6,232.28	$1.25
Depreciation	$632.81	$0.072

Source: Peterson, C. “Feasibility study for commercial production of biodiesel in the Treasure Valley of Idaho”, University of Idaho; Frazier Barnes and Associates, "Arkansas Biodiesel Pre-Feasibility Study”.

3.6 Accounting for Purchase of Renewable Energy Certificates from Outside Tennessee

Four out of five scenarios (8% a and b, 10% a and b) allow the purchase of RECs to meet RPS requirements. For the 8% (a) scenario 3,541,807 MWh are expected to be obtained from the purchase of RECs, for the 8% (b) scenario 2,153,009 MWh would come from RECs, for the 10% (a) scenario RECs are expected to supply 6,033,811 MWh, and for the 10% (b) scenario RECs would supply 4,426,013 MWh of electricity.

According to Holt et al. (2005) there is no single market for RECs. However, there are a variety of separate markets where the prices may vary considerably. Some specific factors that influence the marketing of RECs include RPS policies, the quality and quantity of renewable resources in the region, consumer demand for renewable energy as well as easiness to develop new renewable energy projects and availability of tracking systems.

Other factors that may influence the price of RECs is the renewable source for electricity generation, i.e. in Arizona the price of solar REC is equal to $150/MWh, while the price of RECs from other renewable sources is equal to $15/MWh. Table 14 provides a sample range of RECs trading prices in compliance markets in 2004.

In the current study we assume that for the purposes of meeting RPS requirements Tennessee might buy RECs from Texas due to the relative geographical proximity. Moreover, according to Pollak (2005) and Holt (2005), Texas' RPS as well as its RECs system are considered to be the most successful in the nation. Therefore, the price of the RECs used is equal to $13/MWh (($11+$15)/2). Given this price, the outlays for the RECs would be $45,965,491 for 8% (a) scenario, $27,911,117 for 8% (b) scenario,

$78,361,543 for 10%(a) scenario, and $57,460,169 for 10% (b) scenario. In order to account for the purchase of the RECs in IMPLAN, the production function of the Power Generation and Supply Sector was changed by adding gross absorption coefficient (GAC) under sector 507 (Rest of the world adjustment to final uses). For different scenarios GACs were calculated by dividing RECs expenditures over TIO of the Power Generation and Supply Sector.

Table 14. RECs Prices and Noncompliance Penalties in Different States.

State	2004 REC Trading Prices ($/MWh)	Noncompliance penalty ($/MWh)
Connecticut (Class I)	35-48	55
Maine (Class II)	0.65-0.75	55
New Jersey (Class I)	6.50-7.50	50
New Jersey (Class II)	4.25-5	50
Massachusetts	40-49	51
Texas	11-15	50

Source: Holt et al. 2005. "Emerging Markets for Renewable Energy Certificates: Opportunities and Challenges". National Renewable Energy Laboratory.

Chapter 4

RESULTS

4.1 Results for 5.16% Scenario

Estimated total output and total value added impacts results for the 5.16% scenario are presented in Table 15. For the annual operating impacts, biomass conversion total and direct output and value added impacts were the largest, followed by biomass production and biomass transportation impacts. The sum of total output impacts was estimated at $1.17 billiob. The total value added impacts were equal $712.9 million. For biomass conversion investment total value added impacts were equal to $4.7 million, and total output impacts were equal to $8.6 million.

The industries that were impacted the most are displayed in Tables C.1 through C.3 of Appendix C. The three sectors with the largest TIO direct impacts were co-fire conversion, co-fire production, and truck transportation. The three sectors with the largest indirect impacts were all other crop farming, nondepository credit intermediation, and logging. The three sectors with the largest induced impacts were state and local education, new residential 1-unit structures, and owner-occupied dwellings. The three sectors the largest with employment direct impacts were co-fire production, truck transportation, and co-fire conversion. The three sectors with the largest indirect employment impacts were all other crop farming, gasoline stations, and agriculture and forestry support activities. The three sectors with the largest induced employment impacts were state and local education, state and local non-education, and food service and drinking places.

Total value added and total output multipliers are displayed in Table 15 to the right. For total output impacts the largest multiplier is for biomass transportation – 2.28. For biomass conversion investment impacts, total output multiplier was equal to 2.08. The largest multiplier for total value added impacts had biomass production. It was equal to 4.91. For both total value added and total output impacts the lowest multipliers had biomass conversion annual operating impacts – they were equal to 1.65 and 1.84, respectively.

The estimated amount of total value added and total output per unit of energy provided from biomass co-fire are also displayed in Table 15. For both total value added and total output impacts the largest share per 1,000 MWh had biomass conversion annual operating impacts – \$0.10 and \$0.15, respectively.

4.2 Results for 8%(a) Scenario

For the annual operating impacts under 8%(a) scenario, biomass conversion had the largest total and direct output and total value added impacts, followed by biomass production and biomass transportation impacts (Table 16). The sum of total output impacts was estimated at \$1.17 billion. The sum of total value added impacts was equal to \$712 million. For investment impacts, biomass conversion total value added impacts were equal to \$4.6 million, which is \$39 less than total value added impacts for biomass conversion investment in 5.16% scenario. Total output impacts were \$8.6 million, which is \$13 less than in 5.16% scenario.

The industries that were impacted the most are displayed in Tables C.4 through C.6 of the Appendix C. The three sectors with the largest TIO direct impacts were co-fire conversion, co-fire production, and truck transportation. The three sectors with the largest

indirect impacts were management of companies and enterprises, wholesale trade, and all other cop farming. The three sectors with the largest induced impacts were state and local education, owner-occupied dwellings, and state and local non-education. The three sectors with the largest employment direct impacts were co-fire production, truck transportation, and co-fire conversion. The three sectors with the largest indirect employment impacts were all other crop farming, gasoline stations, and agriculture and forestry support activities. The three sectors with the largest induced employment impacts were state and local education, state and local non-education, and food service and drinking places.

Total value added and total output multipliers are presented in Table 16. For total output impacts the largest multiplier is for biomass transportation – 2.28. For biomass conversion investment impacts, total output multiplier was equal to 2.08. For total value added impacts the largest multiplier had biomass production annual impacts. It was equal to 4.91. For both total value added and total output impacts the lowest multipliers had biomass conversion annual operating impacts – they were equal to 1.65 and 1.84, respectively.

The estimated amount of total value added and total output per unit of energy provided from biomass co-fire are also displayed in Table 16. For both total value added and total output impacts the largest share per 1,000 MWh had biomass conversion annual operating impacts – $0.10 and $0.15, respectively.

Table 15. Estimated Total Output and Total Value Added for 5.16% Scenario.

	Total Output		Multiplier	Total Output /1000 MWh	Total Value Added		Multiplier	Total Value Added /1000 MWh
	Direct	Total			Direct	Total		
Co-fire (Production of Biomass)	108,444,152	207,744,298	1.92	0.04	14,890,498	73,093,606	4.91	0.01
Co-fire (Transportation of Biomass)	25,009,854	56,935,839	2.28	0.01	12,551,865	30,640,709	2.44	0.01
Co-fire (Biomass Conversion - Operating)	494,862,976	909,379,856	1.84	0.15	368,830,208	609,200,385	1.65	0.10
Co-fire (Biomass conversion - investment)	4,138,010	8,626,161	2.08	0.00	2,073,689	4,654,530	2.24	0.00

Table 16. Estimated Total Output and Total Value Added for 8%(a) Scenario.

	Total Output		Multiplier	Total Output / 1000 MWh	Total Value Added		Multiplier	Total Value Added /1000 MWh
	Direct	Total			Direct	Total		
Co-fire (Production of Biomass)	108,444,152	207,743,605	1.92	0.04	14,890,498	73,092,409	4.91	0.01
Co-fire (Transportation of Biomass)	25,009,854	56,935,652	2.28	0.01	12,551,865	30,640,427	2.44	0.01
Co-fire (Biomass Conversion - Operating)	494,862,976	909,379,020	1.84	0.15	368,830,208	609,197,154	1.65	0.10
Co-fire (Biomass conversion - investment)	4,138,010	8,626,148	2.08	0.00	2,073,689	4,654,491	2.24	0.00

4.3 Results for 10% (a) Scenario

As can be seen from Table 17, for the annual operating impacts, biomass conversion total and direct output and value added impacts were the largest, followed by biomass production and biomass transportation impacts. The sum of total output impacts was estimated at $1,174,057,001. The sum of total value added impacts was equal to $712,926,628. For biomass conversion investment impacts, total value added impacts were equal to $4,654,462, which is $68 less than total value added impacts for biomass conversion investment in 5.16% scenario and $29 less than total value added impacts for biomass conversion investment in 8% (a) scenario. Total output impacts for biomass conversion investment impacts were $8,626,138, which is $23 less than in 5.16% scenario and $10 less than in 8%(a) scenario.

The industries that were impacted the most are displayed in Tables C.7 through C.9 of the Appendix C. The three sectors with the largest TIO direct impacts were co-fire conversion, co-fire production, and truck transportation. The three sectors with the largest indirect impacts were management of companies and enterprises, wholesale trade, and all other cop farming. The three sectors with the largest induced impacts were state and local education, owner-occupied dwellings, and state and local non-education. The three sectors with the largest indirect employment impacts were all other crop farming, gasoline stations, and agriculture and forestry support activities. The three sectors with the largest induced employment impacts were state and local education, state and local non-education, and food service and drinking places.

Total value added and total output multipliers are displayed in Table 17 to the right. For total output impacts the largest multiplier is for biomass transportation – 2.28.

Table 17. Estimated Total Output and Total Value Added for 10%(a) Scenario.

	Total Output		Multiplier	Total Output / 1000 MWh	Total Value Added		Multiplier	Total Value Added /1000 MWh
	Direct	Total			Direct	Total		
Co-fire (Production of Biomass)	108,444,152	207,743,126	1.92	0.04	14,890,498	73,091,568	4.91	0.01
Co-fire (Transportation of Biomass)	25,009,854	56,935,517	2.28	0.01	12,551,865	30,640,226	2.44	0.01
Co-fire (Biomass Conversion - Operating)	494,862,976	909,378,358	1.84	0.15	368,830,208	609,194,834	1.65	0.10
Co-fire (Biomass conversion - investment)	4,138,010	8,626,138	2.08	0.00	2,073,689	4,654,462	2.24	0.00

For biomass conversion investment impacts, total output multiplier was equal to 2.08. For total value added impacts the largest multiplier had biomass production annual impacts. It was equal to 4.91. For both total value added and total output impacts the lowest multipliers had biomass conversion annual operating impacts – they were equal to 1.65 and 1.84 respectively. For both total value added and total output impacts the largest share per 1,000 MWh had biomass conversion annual operating impacts – $0.10 and $0.15 respectively (Table 17). As it can be seen from Tables 15 through 17, multipliers and the amount of total output and total value added per 1,000 MWh are the same across the 6.15%, 8%(a) and 10%(a) scenarios.

4.4 Results for 8% (b) Scenario

The results of the analysis for 8% (b) scenario are presented in Tables 18 and 19. For the annual operating impacts, the total output impacts, including direct, indirect, and induced impacts, were the largest for biomass conversion ($902,252,401), followed by biodiesel operating impacts ($272,986,014) and biomass production ($207,834,481). The lowest total output impacts had solar operating ($4,955,292). The total value added impacts were also the largest for biomass conversion and accounted for $609,119,498. The second and third largest total value added impacts had biodiesel (94,092,748) and biomass production ($73,162,549), respectively. Multipliers for total output impacts were the largest for biomass transportation (2.28), solar (2.14), and biomass covenversion (1.96). Multipliers for total value added impacts were the largest for biomass production (4.91), biodiesel operating (3.44), and wind (3.33).Amount of output per 1,000 MWh was the largest for biodiesel ($1.31), while the amount of total value added per 1,000 MWh was the largest for biodiesel ($0.45) and solar ($0.39).

Table 18. Estimated Total Output and Total Value Added for Annual Operating Impacts (8%(b) Scenario).

	Total Output		Multiplier	Total Output /1000 MWh	Total Value Added		Multiplier	Total Value Added / 1000 MWh
	Direct	Total			Direct	Total		
Co-fire (Production of Biomass)	108,444,152	207,834,481	1.92	0.15	14,890,498	73,162,549	4.91	0.10
Co-fire (Transportation of Biomass)	25,009,854	56,928,662	2.28	0.04	12,551,865	30,636,013	2.44	0.01
Co-fire (Biomass Conversion - Operating)	494,862,976	909,252,401	1.84	0.01	368,830,208	609,119,498	1.65	0.01
Wind	58,253,616	114,450,055	1.96	0.17	17,283,729	57,533,276	3.33	0.08
Solar	2,310,732	4,955,292	2.14	0.65	1,498,559	3,023,108	2.02	0.39
Landfill Gas	16,676,440	29,078,440	1.74	0.16	7,828,176	14,279,887	1.82	0.07
Wastewater Gas	10,944,591	18,442,813	1.69	0.19	7,322,085	11,352,075	1.55	0.12
Biodiesel	143,675,760	272,986,014	1.90	1.31	27,322,814	94,092,748	3.44	0.45
Animal Waste	19,380,738	35,149,581	1.81	0.16	10,662,755	20,043,379	1.88	0.09
Total	879,558,859	1,649,077,739	1.92	-	468,190,689	913,242,533	2.56	-

Table 19. Estimated Total Output and Total Value Added for Investment Impacts (8%(b) Scenario).

	Total Output		Multiplier	Total Output /1000 MWh	Total Value Added		Multiplier	Total Value Added /1000 MWh
	Direct	Total			Direct	Total		
Co-fire (Biomass conversion - investment)	4,138,010	8,625,276	2.08	0.00	2,073,689	4,653,922	2.24	0.00
Wind	393,552,317	773,902,990	1.97	1.14	133,435,618	348,270,236	2.61	0.51
Solar	41,636,177	84,856,864	2.04	11.06	10,575,498	35,229,787	3.28	4.59
Landfill Gas	38,038,864	74,469,938	1.96	0.42	11,664,414	32,004,953	2.74	0.18
Wastewater Gas	21,342,065	45,327,132	2.12	0.47	9,109,391	22,766,820	2.5	0.24
Biodiesel	79,755,650	157,947,616	1.98	0.76	33,400,582	77,861,386	2.33	0.37
Animal Waste	67,324,464	131,161,534	1.95	0.60	29,190,142	65,566,502	2.25	0.30
Total	645,787,547	1,276,291,350	2.01	-	229,449,334	586,353,606	2.57	-

Shown in Table 19, the total output impacts from investment were the largest for wind ($773,902,990), biodiesel ($157,947,616), and animal waste ($131,161,534). The lowest total output impact had biomass conversion ($8,625,276). The total value added impacts from investment were also the largest for wind ($348,270,236), biodiesel ($77,861,386), and animal waste ($65,566,502), while the lowest were for biomass conversion (4,653,922). Multipliers for total output impacts were the largest for wastewater gas (2.12), biomass conversion (2.08), and solar investment (2.04). Multipliers for total value added impacts were the largest for solar investment (3.28). Amount of output as well as amount of total value added per 1,000 MWh were the largest for solar investment - $11.06 and $4.59 respectively.

Total value added impacts from solar tax credit were equal to $1,614,538; total employment impacts accounted for 26.7, while total output impacts from solar credit implementation were $2,786,960. Overall, the total output annual operating impacts for 8%(b) Scenario were equal to $1,649,077,739, total output investment impacts were $1,276,291,350. For total annual operating impacts, total value added impacts were equal to $913,242,533; total value added investment impacts were equal to $651,908,568.

The industries that were impacted the most are displayed in Tables C.10 through C.12 of the Appendix C. The three sectors with the largest TIO direct impacts were co-fire conversion, co-fire production, and biodiesel. The three sectors with the largest indirect impacts were management of companies and enterprises, wholesale trade and all other crop farming. The three sectors with the largest induced impacts were state and local education, state and local non-education, and owner-occupied dwellings. The three sectors with the largest employment direct impacts were co-fire production, truck

transportation, and manufacturing and industrial buildings. The three sectors with the largest indirect employment impacts were all other crop farming, oilseed farming, and gasoline stations. The three sectors with the largest induced employment impacts were state and local education, state and local non-education, and food service and drinking places.

4.5 Results for 10% (b) Scenario

From Table 20, the total output annual operating impacts were the largest for biomass conversion ($909,251,840), followed by biodiesel operating impacts ($272,983,352) and biomass production ($207,834,044). The lowest total output impacts had solar operating - $4,955,288. The total value added annual operating impacts were the largest for biomass conversion - $609,117,411. The second and third largest total value added impacts had biodiesel ($94,088,626) and biomass production ($73,161,785), respectively. Multipliers for total output impacts were the largest for biomass transportation (2.28), solar (2.14), and wind (1.96). Multipliers for total value added impacts were the largest for biodiesel production (4.91), biodiesel (3.44) and wind (3.33).Amount of output per 1,000 MWh was the largest for biodiesel ($1.31), while the amount of total value added per 1,000 MWh was the largest for biodiesel (0.45) and solar (0.45).

As shown in Table 21, the total output impacts from investment were the largest for wind ($773,901,149), animal waste ($262,322,556), and biodiesel ($157,943,128). The lowest total output impact had biomass conversion ($8,625,266). The total value added impacts from investment were also the largest for wind ($348,266,811), animal waste ($131,131,908), and biodiesel ($77,851,588), while the lowest were for biomass conversion

Table 20. Estimated Total Output and Total Value Added for Annual Operating Impacts (10%(b) Scenario).

	Total Output				Total Value Added			
	Direct	Total	Multiplier	Total Output /1000 MWh	Direct	Total	Multiplier	Total Value Added / 1000 MWh
Co-fire (Biomass Conversion - Operating)	494,862,976	909,251,840	1.84	0.15	368,830,208	609,117,411	1.65	0.10
Co-fire (Production of Biomass)	108,444,152	207,834,044	1.92	0.04	14,890,498	73,161,785	4.91	0.01
Co-fire (Transportation of Biomass)	25,009,854	56,928,541	2.28	0.01	12,551,865	30,635,832	2.44	0.01
Wind	58,253,616	114,449,780	1.96	0.17	17,283,729	57,532,760	3.33	0.08
Solar	2,310,732	4,955,288	2.14	0.65	1,498,559	3,023,094	2.02	0.39
Landfill Gas	16,676,440	29,078,149	1.74	0.16	7,828,176	12,877,355	1.65	0.07
Wastewater Gas	10,944,591	18,442,766	1.69	0.19	7,322,085	11,351,973	1.55	0.12
Biodiesel	143,675,760	272,983,352	1.90	1.31	27,322,814	94,088,626	3.44	0.45
Animal Waste	38,761,476	70,299,050	1.81	0.16	21,325,510	40,086,504	1.88	0.09
Total	898,939,597	1,684,222,810	1.92	-	478,853,444	931,875,340	2.54	-

Table 21. Estimated Total Output and Total Value Added for Investment Impacts (10%(b) Scenario).

	Total Output		Multiplier	Total Output / 1000 MWh	Total Value Added		Multiplier	Total Value Added / 1000 MWh
	Direct	Total			Direct	Total		
Co-fire (Biomass conversion - investment)	4,138,010	8,625,266	2.08	0.00	2,073,689	4,653,896	2.24	0.00
Wind	393,552,317	773,901,149	1.97	1.14	133,435,618	348,266,811	2.61	0.51
Solar	41,636,177	84,856,608	2.04	11.06	10757498	35,233,016	3.28	4.59
Landfill Gas	38,038,864	74,469,787	1.96	0.42	11,664,414	32,004,663	2.74	0.18
Wastewater Gas	21,342,065	45,327,076	2.12	0.47	9,109,391	22,766,686	2.50	0.24
Biodiesel	79,755,650	157,943,128	1.98	0.76	33,400,582	77,851,588	2.33	0.37
Animal Waste	134,648,928	262,322,556	1.95	0.60	58,380,284	131,131,908	2.25	0.30
Total	713,112,011	1,407,445,570	2.01	-	258,821,476	651,908,568	2.56	-

($4,653,869). Multipliers for total output impacts were the largest for wastewater gas (2.12), biomass conversion (2.08), and solar investment (2.04). Multipliers for total value added impacts were the largest for solar investment (3.28). Amount of output as well as amount of total value added per 1,000 MWh were the largest for solar investment - $11.06 and $4.59, respectively.

Total value added impacts from solar tax credit were equal to $1,614,515; total employment impacts accounted for 26.7, while total output impacts from solar credit were $2,786,950.

Overall, the total output annual operating impacts for 10%(b) Scenario were equal t$1,684,222,810, which is for $35,145,071 higher than for 8%(b) scenario; while total output investment impacts were $1,407,445,570 ($131,154,220 higher than for 8%(b) scenario). For total value added, total annual operating impacts were equal $931,875,340 ($632,807 higher than for 8% (b) scenario); total value added investment impacts were equal $651,908,568, which is for $65,554,962 higher than for 8%(b) scenario.

The industries that were impacted the most are displayed in Tables C.10 through C.12 of the Appendix C. The three sectors with the largest TIO direct impacts were co-fire conversion, co-fire production, and biodiesel. The three sectors with the largest indirect impacts were management of companies and enterprises, wholesale trade and all other crop farming. The three sectors with the largest induced impacts were state and local education, state and local non-education, and owner-occupied dwellings. The three sectors with the largest employment direct impacts were co-fire production, truck transportation, and manufacturing and industrial buildings.

4.6 Employment Results

The analysis showed that employment impacts for different renewables under different RPS scenarios were the same. The summary of the employment impacts is displayed in Tables 22 and 23.

As shown in Table 22, for investment the direct employment impacts for wind were the largest (2,007), followed by animal waste production (2 plants) and biodiesel production. Biomass conversion and solar had the lowest employment impacts– 32 and 126 respectively. The total impacts for investment were also the largest for wind (5,440), animal waste in 10%(b) scenario (1,873), and biodiesel production (1,143). Employment multipliers for investment impacts were the largest for solar (3.97), while the smallest - for biomass conversion (2.34). Overall, for each job added from investment in renewable energy facilities, an additional 2.80 jobs are projected to be created in Tennessee.

For the annual operating impacts biomass production had the largest direct impact (762), followed by biomass transportation (227). Wind and wastewater gas had the lowest direct impacts – 17 and 21 respectively. The total employment impacts were the largest for biomass conversion (4,142), biomass production (1,808), and biodiesel production (1,062). Employment multipliers for investment impacts were the largest for biomass conversion (84.53), while the smallest - for solar (1.74). Overall, for each job added from annual operating activities associated with renewable electricity generation, additional 18 jobs are projected to be created in Tennessee.

Table 22. Estimated Number of Jobs and Employment Multipliers for Investment Impacts.

	Employment (Jobs)		Multiplier
	Direct	Total	
Co-fire (Biomass conversion - investment)	32	75	2.34
Wind	2,007	5,440	2.71
Solar	126	500	3.97
Landfill Gas	205	526	2.57
Biodiesel	444	1,143	2.57
Animal Waste (1 plant)	354	936	2.64
Animal Waste (2 plants)	708	1,873	2.65

Table 23. Estimated Number of Jobs and Employment Multipliers for Annual Operating Impacts.

	Employment (Jobs)		Multiplier
Renewable Energy Technology	Direct	Total	
Co-fire (Biomass Conversion - Operating) – scenarios 8%b, 10%b	49.0	4,144.4	84.58
Co-fire (Production of Biomass) – scenarios 8%b, 10%b	762.0	1,808	2.37
Co-fire (Transportation of Biomass)	227.0	520.0	2.29
Wind	17	473	27.82
Solar	34.0	59.0	1.74
Landfill Gas	26	126	4.85
Wastewater Gas	21	87	4.14
Biodiesel	36.4	1,062.8	29.20
Animal Waste (1 plant)	26	197	7.58
Animal Waste (2 plants)	52	394.2	7.58

4.7 Results for RFS Scenario

The results of the potential impacts from RFS implementation are presented in Tables 24 through 26. Direct and total output impacts for investment were the largest for ethanol, and were equal to $46,681,478 and $91,686,362, respectively. The smallest direct and total output impacts were for biodiesel from yellow grease facilities ($15,506 and $30,190 respectively). The largest output multiplier was for biodiesel from soybeans (1.98). The estimated amount of total output per gallon was also the highest for biodiesel from soybeans, and was equal to $6.07. Total value added impacts for investment impacts were the highest for ethanol ($42,392,228), as was the total value added multiplier (2.50). Total value added per gallon was the highest for biodiesel from soybeans and was equal to $2.99.

As shown in the Table 25, the largest total output and value added impacts for annual operating impacts were for ethanol ($236,773,851 and $99,572,973, respectively). The smallest total output and value added impacts were for biodiesel from yellow grease ($62,410 and $35,526, respectively), which is explained by the small size of the projected facilities.

Industries that were impacted the most are displayed in Tables C.16 through C.18 of Appendix C. The three sectors with the largest TIO direct impacts were ethanol, biodiesel, and all other industrial machinery manufacturing. The three sectors with the largest indirect impacts were oilseed farming, wholesale trade, and grain farming. The three sectors with the largest induced impacts were owner-occupied dwellings, wholesale trade and real estate. The three sectors with the largest employment direct impacts were all other industrial machinery manufacturing, manufacturing and industrial buildings, and

conveyor and conveying equipment manufacturing. The three sectors with the largest indirect employment impacts were oilseed farming, grain farming, and wholesale trade. The three sectors with the largest induced employment impacts were state and local education, state and local non-education, and food service and drinking places.

Estimated employment impacts are presented in Table 26 and show that the largest total output and value added impacts – including direct, indirect, and value added – were for ethanol (652.3 and 1,413, respectively). The largest multiplier for investment was for ethanol (2.64). For annual operating impacts, the largest multiplier was for biodiesel from soybeans (52.97). Moreover, for each job added from annual operating activities associated with producing renewable fuel 2.61 additional jobs are projected to be created in Tennessee. For investment, for each new job associated with producing renewable fuel an additional 31.40 jobs are projected to be created in the state. Overall, the sum of total output annual operating impacts was equal to $351,799,575, and total output investment impacts were $170,614,914. For total value added, total annual operating impacts were equal to $137,338,460, and total value added investment impacts were equal to $81,285,487.

Table 24. Estimated Total Output and Total Value Added for Investment Impacts (RFS)

	Total Output				Total Value Added			
	Direct	Total	Multiplier	Total Output per gallon	Direct	Total	Multiplier	Total Value Added per gallon
Ethanol	46,681,478	91,686,362	1.96	1.91	16,971,083	42,392,228	2.50	0.88
Biodiesel	39,877,825	78,898,362	1.98	6.07	16,699,588	38,878,273	2.33	2.99
Biodiesel from yellow grease	15,506	30,190	1.95	1.51	6,536	14,986	2.29	0.75
Total	86,574,809	170,614,914	1.96	3.16	33,677,207	81,285,487	2.37	1.54

Table 25. Estimated Total Output and Total Value Added for Annual Operating Impacts (RFS)

	Total Output				Total Value Added			
	Direct	Total	Multiplier	Total Output per gallon	Direct	Total	Multiplier	Total Value Added per gallon
Ethanol	128,749,272	236,773,851	1.84	4.93	37,289,116	99,572,973	2.67	2.07
Biodiesel	71,178,648	114,963,314	1.62	8.84	13,536,041	37,729,961	2.79	2.90
Biodiesel from yellow grease	35,678	62,410	1.75	3.12	20,988	35,526	1.69	1.78
Total	199,963,598	351,799,575	1.74	5.63	50,846,145	137,338,460	2.38	2.25

Table 26. Estimated Employment for Investment and Annual Operating Impacts

	Investment			Operating		
	Direct	Total	Multiplier	Direct	Total	Multiplier
Ethanol	246.7	652.3	2.64	36	1,413	39.25
Biodiesel	221.9	571.5	2.58	18	953.4	52.97
Biodiesel from yellow grease	0	0.2	n/a	0.2	0.4	2
Total	468.6	1224.0	2.61	54.2	2366.8	31.40

Chapter 5

SUMMARY AND LIMITATIONS

5.1 Summary

This study was undertaken to obtain estimates of how adopting an RPS and RFS would impact the economy of Tennessee. Using the IMPLAN input-output model, we have showed that meeting RPS in Tennessee can create thousands of new jobs as well as add millions of dollars in output and value added to the state's economy.

For the purposes of this research five scenarios that could be implemented in Tennessee were developed. The first scenario (5.16%) included current renewable generation and biomass co-firing at the existing state's coal fired plants at a co-fire rate of 15 percent. The second (8%(a)) and the third (10%(a)) scenarios were expected to be met with current renewable electricity generation, biomass co-firing in the existing coal facilities and purchase of the renewable energy certificated from outside the state. The mix of renewable resources for the fourth (8%(b)) and fifth (10%(b)) scenarios, except biomass co-fire and out-of-state RECs, included wind, solar, landfill gas, wastewater gas, animal waste, and two biodiesel facilities. For the analysis of the potential impacts of the RFS on the economy of Tennessee one scenario that included such renewable fuels as ethanol, biodiesel from soybeans and biodiesel from yellow grease was developed.

The results from the analysis showed that the largest total output impacts on the Tennessee's economy occurred under the 10%(b) scenario. The total output annual operating impacts for this scenario were equal 1.7 billion dollars, which is for $35 million higher than for 8%(b) scenario (the scenario with the second largest results); while total

output investment impacts were 1.4 billion dollars ($131 million higher than for 8%(b) scenario). For total value added, total annual operating impacts were equal 931 million dollars ($632,807 higher than for 8% (b) scenario); total value added investment impacts were equal 651 million dollars, which is for $65 million higher than for 8%(b) scenario. This implies greater economic benefits for the state to create its own renewable industries rather than just buying RECs from outside the state. The employment impacts showed that overall for the state, for each job added from annual operating activities associated with providing renewable energy, an additional 18 jobs are projected to be created in Tennessee. For investment impacts the overall employment multiplier was equal to 2.80. However, in the future research it is necessary to compare the impacts of electricity generated from renewables under RPS and the same amount of electricity generated from conventional sources.

From the assumptions and results of this study, it would also appear that RFS implementation would be beneficial for Tennessee. Under the RFS scenario, the sum of total output annual operating impacts was equal $351 million, and total output investment impacts were $170 million. For total value added, total annual operating impacts were equal $137 million, and total value added investment impacts were equal $81 million. The estimated number of new jobs created in the state under the RFS scenario was equal 1,224 (for investment impacts), and 2,367 (for annual operating impacts). Therefore, the study shows that except expected environmental benefits from using renewable fuels, meeting RFS requirements in Tennessee would also have beneficial economic impacts through additional output and new jobs created in the state. In the future research it would

be interesting to compare the impacts between ethanol production from corn and cellulosic residues.

5.2 Limitations of IMPLAN Model

There are several limitations of the IMPLAN model that are needed to be accounted for when interpreting the results of the study. First, IMPLAN is a linear model, which means that it assumes constant production function and returns to scale for each firm in the industry. Second, it is assumed in the model that supply of any commodity is unlimited. Third, IMPLAN model does not account for environmental and social costs (or benefits). Finally, IMPLAN does not take in the consideration changes that take place in the economy over the time. For example, if electricity generators would like to substitute some electricity imports with in-state electricity generation, the model would not account for these changes, since regional purchase coefficients are fixed in the model.

REFERENCES

Apollo Alliance for Good Jobs and Clean Energy. 2003. "Renewable Portfolio Standard Model Legislation." http://www.apolloalliance.org/strategy_center/model_legislation/rpsmodel.cfm (Accessed January 2006).

Barkenbus, J., Menard, J., English, B., Jensen, K. 2006. "Resource and Employment Impact of a Renewable Portfolio Standard in the Tennessee Valley Authority Region". University of Tennessee.

Berry, D. 2004. "Commercially Ready Renewable Energy Standard." Presentation to the Arizona Corporation Commission, New Mexico Wind Energy Center. http://159.87.121.155/utility/electric/EPS5-REAPB.ppt (Accessed January 2005).

Binz, R.J. 2004. "The Impact of a Renewable Energy Portfolio Standard on Retail Electric Rates in Colorado." www.environmentcolorado.org/reports/ImpactOfRPS.pdf (Accessed February 2006).

Biodiesel.org. Official Site of the National Biodiesel Board. (Accessed March 2007).

Boyce, H., Cavanaugh, A., Hildebrand, M., Inouye, T., Teepe, A. 2004. "An Analysis of Tradable Credits as a Potential Cost Minimization Tool for California RPS Implementation." University of California, Santa Barbara. http://www.bren.ucsb.edu/research/documents/electricity_final.pdf (Accessed March 2006).

Canada, S., Moore, L., Post, H., Strachan, J. 2005. "Operation and Maintenance Field Experience for Off-grid Residential Photovoltaic Syustem." *Prog. Photovolt: Res. Appl.* (13): 67-74.

Center for Electric Power, Tennessee Technological University. 1999. "Tennessee Greenhouse Emissions: Mitigation Strategies." http://www.tn.gov/ecd/pdf/greenhouse/entiredocument.pdf (Accessed October 2005).

Chen C., White, D., Woolf, T., Johnston, T. 2003. "The Maryland Renewable Portfolio Standard: An Assessment of Potential Cost Impacts." Synapse Energy Economics, Inc. www.marypirg.org/reports/MDsynapserpt3_03.pdf (Accessed January 2006).

Dismukes, D. 2005. "Economic Impacts of New Jersey's Proposed Renewable Portfolio Standard." Acadian Consulting Group. www.state.nj.us/rpa/RPA_David_E_Dismukes_Report.pdf (Accessed December 2005).

Electric Power Research Institute & BBF Consult. 2004. "Renewable Energy Technical Assessment Guide – TAG-RE: 2004". Technical Report – 1008366.

Energy Information Administration. 2002. *Impacts of a 10-percent Renewable Portfolio Standard.* Washington DC. http://tonto.eia.doe.gov/FTPROOT/service/sroiaf(2002)03.pdf (Accessed November 2005).

Energy Information Administration. 2003. *Analysis of a 10-percent Renewable Portfolio Standard.* Washington DC. http://tonto.eia.doe.gov/FTPROOT/service/sroiaf(2003)01.pdf (Accessed December 2005).

Energy Information Administration. 2004. *Net Generation by State by Sector.* Washington DC. http://www.eia.doe.gov/cneaf/electricity/epm/table1_6_b.html (Accessed March 2007).

Energy Information Administration. 2005. *Refiner Motor Gasoline Sales Volumes.* Washington DC. http://tonto.eia.doe.gov/dnav/pet/pet_cons_prim_dcu_STN_a.htm (Accessed March 2007).

Energy Information Administration. 2007. *Annual Energy Outlook 2007 with Projections to 2030.* Washington DC. http://www.eia.doe.gov/oiaf/aeo/excel/aeohptab_12.xls (Accessed April 2007).

Energy Information Administration. 2007. *Coal Production and Number of Mines by State and Mine Type.* Washington DC. http://www.eia.doe.gov/cneaf/coal/page/acr/table1.html (Accessed April 2007).

Energy Information Administration. 2007. *U.S. Coal Consumption by End Use Sector, by Census Division and State, 2005, 2004.* Washington DC. http://www.eia.doe.gov/cneaf/coal/page/acr/table26.html (Accessed March 2007).

Energy Information Administration. 2007. *Average Sales Price of U.S. Coal by State and Mine Type.* Washington DC. http://www.eia.doe.gov/cneaf/coal/page/acr/table33.html (Accessed April 2007).

Energy Information Administration. 2007. *Supplemental Tables to the Annual Energy Outlook for 2007.* Washington DC. http://www.eia.doe.gov/oiaf/aeo/supplement/index.html (Accessed March 2007).

English, B., K. Jensen, and J. Menard in cooperation with Frazier, Barnes & Associates, Llc. 2002. "Economic Feasibility of Producing Biodiesel in Tennessee". http://beag.ag.utk.edu/pp/biodiesel.pdf (Accessed November 2006).

English, B., J. Menard, M. Walsh, and K. Jensen. 2004. "Economic Impacts of Using Alternative Feedstocks in Coal-Fired Plants in the Southeastern United States". http://beag.ag.utk.edu/pp/New%20Cofire%20Study%20Doc.pdf (Accessed November 2006).

Environmental Protection Agency, Landfill Methane Outreach Program. 2005. Documents, Tools, and Resources. Energy Project Landfill Gas Utilization Software (E-Plus).

Environmental Protection Agency. 2006. *Regulations of Fuels and Fuel Additives: Renewable Fuel Standard Requirements for 2006.* Washington DC. http://www.epa.gov/EPA-AIR/2005/December/Day-30/a24610.htm (Accessed October 2006).

Findsolar.com. 2007. A solar-powered site by Energy Matters, LLC (Accessed March 2007).

Frazier Barnes and Associates, LLC. 2004. "Arkansas Biodiesel Pre-Feasibility Study". Prepared for Winrock International. http://www.winrock.org/us_programs/files/Winrock_US_AR_biodiesel_final_report.pdf (Accessed February 2007).

Grace, B., Wiser R. 2003. "Crafting a Renewables Portfolio Standard for Rhode Island: Design Choices, Best Practices, and Recommendations." http://righg.raabassociates.org/Articles/RPS-Design-final.doc (Accessed January 2006).

Green Car Congress. 2006. "State Ethanol Mandates Inching Ahead". http://www.greencarcongress.com/2006/03/state_ethanol_m.html (Accessed May 2006)

Green Car Congress. 2006. "Washington State House Passes Renewable Fuel Standard". http://www.greencarcongress.com/2006/02/washington_stat.html (Accessed May 2006)

Green Car Congress. 2006. "Louisiana Legislature Passes 2% Renewable Fuel Standard". http://www.greencarcongress.com/2006/06/louisiana_legis.html (Accessed August 2006)

Hamrin, J., Lieberman, D., Wingate, M. 2006. "Regulator's Handbook on Renewable Energy Programs and Tariffs". Center for Resource Solution. http://www.resource-solutions.org/policy/TariffHandbook/Handbook_on_Renewable_Energy_Programs_&_Tariffs.pdf (Accessed November 2006).

Holland, D., Beleiciks, N. 2006. "The Economic Impact of Potatoes in Washington State". Washington State University Extension. http://www.agribusiness-mgmt.wsu.edu/AgbusResearch/docs/potatoes/eb1953e.pdf (Accessed March 2007).

Holt, E., Bird, L. 2005. "Emerging Markets for Renewable Energy Certificates: Opportunities and Challenges". National Renewable Energy Laboratory. http://www.eere.energy.gov/greenpower/resources/pdfs/37388.pdf (Accessed December 2006).

Irish Wind Energy Association. 2001. "Peat-fired Electricity Given Preferential Treatment Over Renewable Energy." http://www.iwea.com/pressrealeases/11sept01.pdf (Accessed August 2006).

Kammen, D., Kapadia, K., Matthias, F. 2004. "Putting Renewables to Work: How Many Jobs Can the Clean Industry Generate?" Renewable and Appropriate Energy Laboratory. http://rael.berkeley.edu/files/2004/Kammen-Renewable-Jobs-2004.pdf (Accessed December 2006).

Legislature of the State of Idaho. 2006. Senate Bill No. 1267. http://www3.state.id.us/oasis/2006/S1267.html (Accessed August 2006).

Madsen, T., Bonin, S., Baker, M. 2002. "Wind Energy: Powering Economic Development for Colorado." Colorado Public Interest Research Group. http://copirg.org/report/windenergy11_02.pdf (Accessed November 2005).

Minnesota IMPLAN Group, Inc. 1997. "IMPLAN Professional. Social Accounting & Impact Analysis Software".

McAloon, A., Taylor, F., Yee, W., Ibsen, K., and Wooley, R. 2000. "Determining the Cost of Producing Ethanol from Corn Starch and Lignocellulosic Feedstocks". National Renewable Energy Laboratory (NREL/TP-580-28893). http://www.ethanol-gec.org/information/briefing/16.pdf (Accessed October 2006)

National Renewable Energy Laboratory. 2005. "Methane Emissions from Domestic Wastewater Treatment". http://www.nrel.gov/docs/fy06osti/39181.pdf (Accessed November 2006).

National Renewable Energy Laboratory. 2006. "Wind Resource Assessment." http://www.nrel.gov/gis/wind_maps.html (Accessed March 2006).

Oil Price Information Service. 2006. OPIS Wholesale B100 SME Biodiesel Gross Prices. http://www.opisnet.com/bioracksample.pdf (Accessed April 2007).

Official Nebraska Government Website. 2007. "Ethanol and Unleaded Gasoline Average Rack Prices". http://www.neo.ne.gov/statshtml/66.html (Accessed April 2007).

Palmer K., Burtraw, D. 2005. "Cost-Effectiveness of Renewable Electricity Policies." Discussion Paper. Washington DC. http://www.rff.org/Documents/RFF-DP-05-01.pdf (Accessed January 2006).

Peterson, C. 2006. "Feasibility study for commercial production of biodiesel in the Treasure Valley of Idaho", University of Idaho. http://www.idwr.idaho.gov/energy/alternative_fuels/FeasibilityStudy.pdf (Accessed January 2007).

Pollak, D. 2005. "Tradable Renewable Energy Credits and the California Renewable Portfolio Standard." California Research Bureau. www.nationalwind.org/publications/rec/rec_guide.pdf (Accessed March 2006).

Rabe, B. 2006. Race to the Top: The Expanding Role of U.S. State Renewable Portfolio Standards". University of Michigan. http://www.pewclimate.org/docUploads/RPSReportFinal.pdf (Accessed October 2006).

Rader, N. 2000. "The Hazards of Implementing Renewables Portfolio Standards". *Energy and Environment*, April, pp. 391-405.

Rader N., Hempling, S. 2001. "The Renewable Portfolio Standard: A Practical Guide." Apollo Alliance for Good Jobs and Clean Energy. www.apolloalliance.org/strategy_center/model_legislation/rpsmodel.cfm (Accessed February 2006).

Singh, V., Fehrs, J. 2001. "The Work That Goes into Renewable Energy". Research Project. http://www.earthscape.org/p1/ES16317/LABOR%20renew.pdf (Accessed March 2007).

Tennessee Valley Authority. 2005. "TVA to Expand Buffalo Mountain Wind Generation Tenfold." http://www.tva.gov/news/releases/janmar03/morewind.htm (Accessed March 2007).

Texas' State Energy Conservation Office. 2006. "Estimating PV System Size and Cost." SECO Fact Sheet No. 24. http://www.infinitepower.org/pdf/FactSheet-24.pdf (Accessed March 2007).

Union of Concerned Scientists. 2005. "Increasing Wisconsin's Renewable Portfolio Standard Will Create Jobs and Help Stabilize Energy Bills". http://www.ucsusa.org/clean_energy/clean_energy_policies/increase-wisconsin-rps.html (Accessed December 2006).

Union of Concerned Scientists. 2005. "Renewing Texas' Economy". http://www.ucsusa.org/clean_energy/renewable_energy_basics/renewing-americas-economy.html (Accessed December 2006).

Union of Concerned Scientists. 2005. "Renewing America's Economy". http://www.ucsusa.org/clean_energy/renewable_energy_basics/renewing-americas-economy.html (Accessed December 2006).

Urbanchuk J.M. 2003. "Consumer Impacts of the Renewable Fuel Standard". LECG, LLC. http://www.ethanol.org/pdfs/consumer_impacts.pdf (Accessed May 2006).

Urbanchuk J.M., Kapell J. 2002. "Ethanol and the local community". AUS Consultants and SJH & Company. http://www.ethanol.org/pdfs/ethanol_effects.pdf (Accessed May, 2006)

U.S. Department of Energy. 2005. *Clean Cities Alternative Fuel Report*. Washington DC. http://www.eere.energy.gov/afdc/resources/pricereport/pdfs/afpr_09_01_05.pdf (Accessed November 2006).

U.S. Department of Energy. 2005. *The Energy Policy Act of 2005*. Washington DC. http://www1.eere.energy.gov/femp/about/legislation_epact_05.html (Accessed Decemebr 2006).

U.S. Department of Energy, Energy Efficiency and Renewable Energy. 2007. *States with Renewable Portfolio Standards*. Washington DC. http://www.eere.energy.gov/states/maps/renewable_portfolio_states.cfm (Accessed March 2007).

Wind, T. 2001. "Projected Impact of Renewable Portfolio Standard on Minnesota's Electricity Prices." Wind Utility Consulting. http://www.rbinz.com/Files/Binz%20RPS%20Colorado%20Report.pdf (Accessed August 2006).

Wiser, R., Langniss, O. 2001. "The Renewables Portfolio Standard in Texas: An Early Assessment". *Energy Policy* 31(6): 527-535.

Wiser, R., Porter, K., Grace, R., Kappel, C. 2003. "Evaluating State Renewables Portfolio Standards: A Focus on Geothermal Energy". Executive summary, National Geothermal Collaborative. http://www.geocollaborative.org/publications/RPS.pdf (Accessed March 2006).

APPENDICES

APPENDIX A

Table A.1. Expenditures Distribution for Horizontal Axis Wind Turbine Power Plant.

Facility Size: 10 turbines at 1.5MW per turbine capacity=15 MW or 39,420,000 kWh per year (at 30% capacity factor).
Total Industry Output: 39,420,000 kWh per year * $.0901 per kWh=$3,551,742
Employees: 6

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures (2005$)	Share, %
Investment	41	Other New Construction (Foundations, Civil engineering, Installation & Commissioning, etc.)	$3,500,856	15.3
Investment	285	Turbine & Turbine Generator Set Units Manufacturing (Tower, Wind Turbine/Generator, Power Collection System)	$6,522,391	28.5
Investment	316	Industrial Process Variable Instruments (Electrical/Controls/Instrumentation)	$2,961,054	12.9
Investment	334	Motor & Generator Manufacturing (Rotor Assembly)	$3,781,764	16.5
Investment	394	Truck Transportation (Transportation & Freight)	$926,828	4.1
Investment	437	Legal Services (Due Diligence, Permitting, Legal)	$1,593,305	7.0
Investment	439	Architectural & Engineering Services (Engineering)	$125,746	0.5
Investment	442	Computer Systems Design Services (SCADA & Communications)	$109,453	0.5
Investment	499	Other State & Local Govt. Enterprises (Tax and Fees)	$3,346,872	14.6
Operating	485	Commercial Machinery Repair & Maintenance (includes Turbines, BOP, insurance, admin.)	$569,187	-
Depreciation	41	Other New Construction (Foundations, Civil engineering, Substation, Metering, Interconnection, Sensors, etc.)	$161,101	10.8
Depreciation	285	Turbine & Turbine Generator Set Units Manufacturing (Tower, Wind Turbine/Generator, Power Collection System)	$652,239	43.8
Depreciation	316	Industrial Process Variable Instruments (Electrical/Controls/Instrumentation)	$296,105	19.9
Depreciation	334	Motor & Generator Manufacturing (Rotor Assembly)	$378,176	25.4

Table A.1. continued.

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures 2005$
Value-Added	5001	Employee Compensation	$355,822.97
Value-Added	6001	Proprietary Income	$95,233.25
Value-Added	7001	Other Property Income	$619,371.70
Value-Added	8001	Indirect Business Tax	$339,924.38
Employees	20001	Employees[a]	6

Source: Electric Power Research Institute & BBF Consult. 2004. "Renewable Energy Technical Assessment Guide – TAG-RE: 2004". Technical Report – 1008366.

[a] Employment based upon Irish Wind Energy Association Estimates of 3 persons per 10MW wind farm.

Table A.2. Expenditures Distribution For PV Panels Installation

Facility Size: Substation Capacity: 7,674,000 kWh (8.48 MWh* 905)
Employees[b]: 32

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)	Share, %
Investment	311	Semiconductors and Related Device Manufacturing (PV arrays)	$25,525,413	48.74
Investment	337	Storage Battery Manufacturing (Battery Bank)	$7,782,068	14.86
Investment	343	Miscellaneous Electrical Equipment Manufacturing (Inverter)	$3,803,862	7.26
Investment	335	Switchgear and Switchboard Apparatus Manufacturing (Fuses, Switches, etc.)	$6,092,129	11.63
Investment	507	Rest of the World Adjustment to Final Uses (Installation Costs)	$6,998,281	13.36
Operating	45	Other Maintenance and Repair Construction (O&M Costs)	$2,166,708	4.14

Source: Canada, S., Moore, L., Post, H., Strachan, J. 2005. "Operation and Maintenance Field Experience for Off-grid Residential Photovoltaic Syustem." *Prog. Photovolt: Res. Appl.* (13): 67-74; Texas' State Energy Conservation Office. 2006. "Estimating PV System Size and Cost." SECO Fact Sheet No. 24.

[b] Employment based upon study by Singh, V., Fehrs, J. 2001. "The Work That Goes into Renewable Energy". Research Project.

Table A.3. Expenditures Distribution for Landfill Gas Conversion.

Facility Size: Substation Capacity: 4,594 kW
Total Industry Output: 34,457,555 kWh*$.0901/kWh=$3,104,625.7
Employees: 5

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)	Share, %
Investment	41	Other New Construction (Electricity Generation Installation & Other Costs, Gas Treatment Installation & Other Costs, Inter Connect Installation & Other Costs)	$1,937,017	26.89
Investment	205	Iron, Steel Pipe & Tube from Purchased Steel (Pipe)	$1,438,066	19.96
Investment	239	Metal Tank, Heavy Gauge, Manufacturing (Condensate Knockout)	$104,000	1.44
Investment	261	Oil & Gas Field Machinery & Equipment (Well & Well Heads)	$738,750	10.26
Investment	275	Air Purification Equipment Manufacturing (Filters)	$16,000	0.22
Investment	276	Industrial & Commercial Fan and Blower Manufacturing (Blowers)	$49,547	0.69
Investment	277	Heating Equipment, except Warm Air Furnaces (Radiator Costs)	$229,684	3.19
Investment	289	Air & Gas Compressor Manufacturing (Compressor)	$88,973	1.24
Investment	298	Industrial Process Furnace & Oven Manufacturing (Flares)	$75,000	1.04
Investment	316	Industrial Process Variable Instruments (Monitor)	$1,000	0.01
Investment	333	Electric Power & Specialty Transformer Manufacturing (Substation Costs & Intertie Wiring Costs)	$305,622	4.24
Investment	336	Relay & Industrial Control Manufacturing (Protective Relays Costs)	$45,937	0.64
Investment	341	Wiring Device Manufacturing (System Disconnect Costs)	$91,874	1.28
Investment	350	Motor Vehicle Parts Manufacturing (IC Low Engine & Engineer Wiring Costs)	$2,071,662	28.76
Investment	442	Computer Systems Design Services (Substation Telemetry Costs)	$10,000	0.14
Operating	485	Commercial Machinery Repair & Maintenance (Collection System Variable O&M, Compression System Variable O&M,)	$939,368	
Depreciation	41	Other New Construction (Electricity Generation Installation & Other Costs, Gas Treatment Installation & Other Costs, Inter Connect Installation & Other Costs)	$193,702	26 93
Depreciation	205	Iron, Steel Pipe & Tube from Purchased Steel (Pipe)	$143,807	19.99
Depreciation	239	Metal Tank, Heavy Gauge, Manufacturing (Condensate Knockout)	$10,400	1.45
Depreciation	261	Oil & Gas Field Machinery & Equipment (Well & Well Heads)	$73,875	10.27
Depreciation	275	Air Purification Equipment Manufacturing (Filters)	$1,600	0.22
Depreciation	276	Industrial & Commercial Fan and Blower Manufacturing (Blowers)	$4,955	0.69
Depreciation	277	Heating Equipment, except Warm Air Furnaces (Radiator Costs)	$22,968	3.19
Depreciation	289	Air & Gas Compressor Manufacturing (Compressor)	$8,897	1.24
Depreciation	298	Industrial Process Furnace & Oven Manufacturing (Flares)	$7,500	1.04
Depreciation	316	Industrial Process Variable Instruments (Monitor)	$100	0.01
Depreciation	333	Electric Power & Specialty Transformer Manufacturing (Substation Costs & Intertie Wiring Costs)	$30,562	4.25
Depreciation	336	Relay & Industrial Control Manufacturing (Protective Relays Costs)	$4,594	0.64
Depreciation	341	Wiring Device Manufacturing (System Disconnect Costs)	$9,187	1.28
Depreciation	350	Motor Vehicle Parts Manufacturing (IC Low Engine & Engineer Wiring Costs)	$207,166	28.80

Table A.3. continued.

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)
Value-Added	5001	Employee Compensation	$217,825.24
Value-Added	6001	Proprietary Income	$85,439.21
Value-Added	7001	Other Property Income	$937,471.08
Value-Added	8001	Indirect Business Tax	$113,732.29
Employees	20001	Employees	5

Source: Environmental Protection Agency, Landfill Methane Outreach Program. 2005. Documents, Tools, and Resources. Energy Project Landfill Gas Utilization Software (E-Plus)

Table A.4. Expenditures Distribution for Wastewater Gas.

Facility size: 12,264,000 kWh/year
Total Industry Output: 12,264,000 kWh/year*$0.0901 = $1,104,986.4
Employees: 2.6

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)
Investment	41	Other New Construction (Cement Work, Piping Installation, Excavating/Grading, Building, Component Installation)	$2,531,698.59
Operating	485	Commercial Machinery Repair & Maintenance (Engine Maintenance)	$598,167.49
Byproduct	30	Power Generation and Supply (Projected Annual Electric Revenue)	$7,648.91

Table A.4. continued.

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)
Value-Added	5001	Employee Compensation	$113,269.13
Value-Added	6001	Proprietary Income	$56,184.14
Value-Added	7001	Other Property Income	$616,473.51
Value-Added	8001	Indirect Business Tax	$49,105.39
Employees	20001	Employees	2.6

Source: Utah SLC Public Utilities Department

Table A.5. Expenditures Distribution for Biodiesel from Soybeans Conversion.

Facility Size: 13.0 MM Gal/year
Total Industry Output: 13,000,000 gallons/year*$3.73 = $48,490,000
Employees: 18

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)	Share, %
Investment	30	Power Generation & Supply (Utilities)	$1,512,961	3.57
Investment	37	Manufacturing & Industrial Bldgs. (Buildings, Civil/Mechanical/Electrical, Land/Prep/Trans Access)	$8,898,334	20.97
Investment	150	Other Basic Inorganic Chemical Manufacturing (Solvent Extraction)	$7,321,385	17.25
Investment	239	Metal Tank, Heavy Gauge, Manufacturing (Preparation and Mill Feed/Meal Sizing)	$5,491,458	12.94
Investment	269	All Other Industrial Machinery Manufacturing (Peripherals)	$3,320,284	7.83
Investment	292	Conveyor & Conveying Equipment Manufacturing (Feedstock & Product Storage and Handling)	$13,149,467	30.99
Investment	425	Banking (Contingency (10%))	$2,068,719	4.88
Investment	431	Real Estate (Land)	$240,132	0.57
Investment	439	Architectural & Engineering Services (Engineering/Permitting)	$421,266	0.99
Investment	451	Management of Companies & Enterprises (Set-up Consulting)	$6,651	0.02
Operating	1	Oilseed Farming (Feedstock)	$62,306,400	85.04
Operating	30	Power Generation & Supply	$412,486	0.56
Operating	32	Water, Sewage & Other Systems	$1,157,819	1.58
Operating	54	Fats & Oils Refining & Blending (Depreciation)	$3,127,648	4.27
Operating	148	Industrial Gas Manufacturing	$40,715	0.06
Operating	150	Other Basic Inorganic Chemical Manufacturing	$278,751	0.38
Operating	151	Other Basic Organic Chemical Manufacturing	$1,147,089	1.57
Operating	425	Banking	$1,876,816	2.56
Operating	427	Insurance Carriers	$356,194	0.49
Operating	438	Accounting	$2,012,166	2.75
Operating	485	Commercial Machinery Repair & Maintenance	$546,846	0.75
Depreciation	30	Power Generation & Supply (Utilities)	$144,762	4.06
Depreciation	37	Manufacturing & Industrial Bldgs. (Buildings, Civil/Mechanical/Electrical, Land/Prep/Trans Access)	$434,068	12.18
Depreciation	150	Other Basic Inorganic Chemical Manufacturing (Solvent Extraction)	$735,999	20.66
Depreciation	239	Metal Tank, Heavy Gauge, Manufacturing (Preparation and Mill Feed/Meal Sizing)	$538,886	15.13
Depreciation	269	All Other Industrial Machinery Manufacturing (Peripherals)	$330,680	9.28
Depreciation	292	Conveyor & Conveying Equipment Manufacturing (Feedstock & Product Storage and Handling)	$1,365,907	38.34
Depreciation	431	Real Estate (Land)	$12,575	0.35
Byproduct	151	Glycerine Credit	$8,678,181	-
Byproduct	163	Soapstock Credit	$141,632	-
Byproduct	506	Federal Non-military	$15,274,837	-

Table A.5. continued.

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)
Value-Added	5001	Employee Compensation	$1,432,648.20
Value-Added	6001	Proprietary Income	$1,512,167.67
Value-Added	7001	Other Property Income	$9,656,075.43
Value-Added	8001	Indirect Business Tax	$623,823.66
Employees	20001	Employees	18

Source: English, B., K. Jensen, and J. Menard in cooperation with Frazier, Barnes & Associates, Llc. 2002. "Economic Feasibility of Producing Biodiesel in Tennessee".

Table A.6. Expenditure Distribution for Wood Fired Power Plant.

Facility Size: 219,000,000 kWh/year = 219,000 MWh/year
Total Industry Output: 219,000,000 kWh/year*$0.0901= $19,731,900
Employees: 26

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)	Share, %
Investment	37	Manufacturing & Industrial Buildings (Concrete Substructures, Piping, Electrical, Insulation, Process Structural, Stack)	$11,832,678.83	16.40
Investment	161	Paint & Coating Manufacturing (Paint)	$144,254.30	0.20
Investment	203	Iron & Steel Mills (Structural Steel)	$2,464,137.04	3.42
Investment	240	Metal can, box, & Other Container Manufacturing (Receiving Hopper/Magnet, Reclaim Hopper, Feed Bin)	$19,955.57	0.03
Investment	259	Construction Machinery Manufacturing (Hammer Mill/Hopper, Dozer 1, & Dozer 2)	$1,127,448.63	1.56
Investment	273	Other Commercial & Service Industry Machinery Manufacturing (Demineralizer Plant)	$164,084.83	0.23
Investment	277	Heating Equipment, except Warm Air Furnaces (No. 2 Oil Burners (4X))	$590,367.69	0.82
Investment	278	AC, Refrigeration, & Forced Air Heating (Cooling Tower)	$2,485,179.74	3.44
Investment	285	Turbine & Turbine Generator Set Units Manufacturing (Stoker Steam Generator, Steam Turbine/Generator Set)	$18,341,928.32	25.42
Investment	292	Conveyor & Conveying Equipment Manufacturing (Rotary Disc Screen/Hopper, RDS Conveyor, HM Conveyor, Reclaim Conveyor, Feed Conveyor)	$231,226.56	0.32
Investment	315	Automatic Environmental Control Manufacturing (NOx Control _SNCR, CEMS)	$1,452,976.14	2.01
Investment	316	Industrial Process Variable Instruments (Instrumentation)	$2,200,265.94	3.05
Investment	346	Motor Vehicle Body Manufacturing (Truck Scale/Unloader)	$107,347.49	0.15
Investment	425	Banking (Contingency Fee)	$12,853,726.41	17.82
Investment	451	Management of Companies & Enterprises (Home Office Expense (w/Overhead), Field Expenses (w/Overhead), Contractor Fees)	$18,133,797.62	25.13
Operating	14	Logging (Feedstock)	$3,145,843.49	-
Operating	485	Commercial Machinery Repair & Maintenance (Maintenance)	$2,832,814.55	-
Depreciation	37	Manufacturing & Industrial Buildings (Concrete Substructures, Piping, Electrical, Insulation, Process Structural, Stack)	$591,634.50	17.39
Depreciation	161	Paint & Coating Manufacturing (Paint)	$14,425.78	0.42
Depreciation	203	Iron & Steel Mills (Structural Steel)	$123,207.00	3.62
Depreciation	240	Metal can, box, & Other Container Manufacturing (Receiving Hopper/Magnet, Reclaim Hopper, Feed Bin)	$1,995.45	0.06
Depreciation	259	Construction Machinery Manufacturing (Hammer Mill/Hopper, Dozer 1, & Dozer 2)	$112,745.09	3.31
Depreciation	273	Other Commercial & Service Industry Machinery Manufacturing (Demineralizer Plant)	$16,408.94	0.48
Depreciation	277	Heating Equipment, except Warm Air Furnaces (No. 2 Oil Burners (4X))	$59,036.32	1.74
Depreciation	278	AC, Refrigeration, & Forced Air Heating (Cooling Tower)	$248,518.08	7.31
Depreciation	285	Turbine & Turbine Generator Set Units Manufacturing (Stoker Steam Generator, Steam Turbine/Generator Set)	$1,834,192.94	53.93
Depreciation	292	Conveyor & Conveying Equipment Manufacturing (Rotary Disc Screen/Hopper, RDS Conveyor, HM Conveyor, Reclaim Conveyor, Feed Conveyor)	$23,122.99	0.68
Depreciation	315	Automatic Environmental Control Manufacturing (NOx Control _SNCR, CEMS)	$145,297.72	4.27
Depreciation	316	Industrial Process Variable Instruments (Instrumentation)	$220,026.37	6.47
Depreciation	346	Motor Vehicle Body Manufacturing (Truck Scale/Unloader)	$10,734.53	0.32

Table A.6. continued.

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)
Value-Added	5001	Employee Compensation	$1,541,899.53
Value-Added	6001	Proprietary Income	$882,684.58
Value-Added	7001	Other Property Income	$5,740,745.48
Value-Added	8001	Indirect Business Tax	$1,888,468.77
Employees	20001	Employees	26

Source: Electric Power Research Institute & BBF Consult. 2004. "Renewable Energy Technical Assessment Guide – TAG-RE: 2004". Technical Report – 1008366

Table A.7. Expenditures Distribution for 15-% Co-fire of Cellulosic Residues with Coal.

Facility Size: 137,313,000 kWh/year = 137,313 MWh/year
Total Industry Output: 137,313,000 kWh/year*$0.0901 = $11,790,949
Employees: 7

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)	Share, %
Investment	41	Other New Construction (Biomass Handling System Installation, Civil Structural, Electrical)	$2,039,079	49.28
Investment	232	Prefabricated Metal Buildings and Components (Wood Silo with Live Bottom)	$48,747	1.18
Investment	292	Conveyor & Conveying Equipment Manufacturing (Conveyor #1, Radial Stacker, Radial Screw, Conveyor #2, etc.)	$477,623	11.54
Investment	298	Industrial Process Furnace & Oven Manufacturing (Modification at Burners)	$33,758	0.82
Investment	316	Industrial Process Variable Instruments (Controls)	$163,013	3.94
Investment	346	Motor Vehicle Body Manufacturing (Truck Tipper with Hopper and Feeder)	$110,642	2.67
Investment	425	Banking (Contingency (30%))	$873,404	21.11
Investment	439	Architectural & Engineering Services (Engineering @ 10%)	$391,746	9.47
Operating	485	Commercial Machinery Repair & Maintenance (Repair)	$264,964	2.25
Operating	2, 10, 14, 112	Feedstock	-	-
Depreciation	41	Other New Construction (Biomass Handling System Installation, Civil Structural, Electrical)	$203,908	71 58
Depreciation	232	Prefabricated Metal Buildings and Components (Wood Silo with Live Bottom)	$2,437	0.86
Depreciation	292	Conveyor & Conveying Equipment Manufacturing (Conveyor #1, Radial Stacker, Radial Screw, Conveyor #2, etc.)	$47,762	16.77
Depreciation	298	Industrial Process Furnace & Oven Manufacturing (Modification at Burners)	$3,376	1.19
Depreciation	316	Industrial Process Variable Instruments (Controls)	$16,301	5.72
Depreciation	346	Motor Vehicle Body Manufacturing (Truck Tipper with Hopper and Feeder)	$11,064	3.88

Table A.7. continued

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)
Value-Added	5001	Employee Compensation	
Value-Added	6001	Proprietary Income	
Value-Added	7001	Other Property Income	
Value-Added	8001	Indirect Business Tax	
Employees	20001	Employees[a]	

Source: English, B., J. Menard, M. Walsh, and K. Jensen. 2004. "Economic Impacts of Using Alternative Feedstocks in Coal-Fired Plants in the Southeastern United States".

Table A.8. Expenditure Distribution for Ethanol from Shelled Corn (Dry Mill).

Facility Size: 48,000,000 gallons per year
Total Industry Output: 48,000,000 gallons/year*$2.31 = $110,880,000
Employees: 36

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)	Share, %
Investment	239	Metal Tank, Heavy Gauge, Manufacturing (Saccharification, Storga/Load Out))	$5,976,200	12.80
Investment	269	All Other Industrial Machinery Manufacturing (Fermentation, Distillation, Solid/SyrupSeparation/Drying)	$34,374,147	73.64
Investment	289	Air and Gas Compressor Manufacturing (Air Compressor)	$174,263	0.37
Investment	292	Feedstock Handling	$4,403,674	9.43
Investment	460	Waste Management and Remediation Services (Wastewater treatment)	$1,753,198	3.76
Operating	2	Grain Farming (Feedstock)	$42,555,182	50.86
Operating	30	Power Generation and Supply (Electricity)	$2,119,611	2.53
Operating	31	Natural Gas Distribution (Natural Gas)	$26,771,588	32.00
Operating	32	Water, Sewage and Other Systems (Makeup Water, Steam, CT Water, Cool Water)	$348,813	0.42
Operating	84	All Other Food Manufacturing (Yeast)	$1,185,940	1.42
Operating	150	Other Basic Inorganic Chemical Manufacturing (Caustic)	$1,213,854	1.45
Operating	151	Other Basic Organic Chemical Manufacturing (Gluco-Anylase)	$2,721,072	3.25
Operating	390	Wholesale Trade Department (Denaturant (Gasoline))	$1,262,352	1.51
Operating	411	Miscellaneous Store Retailers (Operating Supplies)	$682,204	0.82
Operating	425	Banking (Interest Expense)	$2,817,415	3.37
Operating	427	Insurance Carriers (Insurance and Local Taxes)	$342,788	0.41
Operating	451	Management of Companies and Enterprises (Consulting Services)	$796,205	0.95
Operating	485	Commercial Machinery Repair and Maintenance (Maintenance Supplies)	$852,828	1.02
Depreciation	239	Metal Tank, Heavy Gauge, Manufacturing (Saccharification, Storga/Load Out))	$597,620	13.30
Depreciation	269	All Other Industrial Machinery Manufacturing (Fermentation, Distillation, Solid/SyrupSeparation/Drying)	$3,437,415	76.51
Depreciation	289	Air and Gas Compressor Manufacturing (Air Compressor)	$17,426	0.39
Depreciation	292	Feedstock Handling	$440,367	9.80
Byproduct	47	Other Animal Food Manufacturing (DDGS)	$13,142,915	

Table A.8. continued.

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)
Value-Added	5001	Employee Compensation	2,272,176.66
Value-Added	6001	Proprietary Income	8,022,871.73
Value-Added	7001	Other Property Income	48,347,938.26
Value-Added	8001	Indirect Business Tax	710,027.93
Employees	20001	Employees[a]	36

Source: McAloon, A., Taylor, F., Yee, W., Ibsen, K., and Wooley, R. 2000. "Determining the Cost of Producing Ethanol from Corn Starch and Lignocellulosic Feedstocks". National Renewable Energy Laboratory. Joint study sponsored by USDA and DOE.

Table A.9. Expenditure Distribution for Biodiesel from Yellow Grease Batch Technology.

Facility Size: 5,000 kWh/year = 5 MWh/year
Total Industry Output: 5,000 kWh/year*$3.23 = $16,150
Employees: 0.1

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)	Share, %
Investment	292	Conveyor & Conveying Equipment Manufacturing (Transesterfication Machinery)	5,114.8	65.97%
Investment	239	Metal Tank, Heavy Gauge, Manufacturing (Storage Tanks)	959.7	12.38%
Investment	37	Manufacturing and Industrial Buildings (Building)	793.9	10.24%
Investment	439	Architectural and Engineering Services (Permits/misc.)	159.9	2.06%
Investment	425	Banking (Working Capital)	725.0	9.35%
Operating	54	Fats and Oils Refining and Blending (Yellow Grease)	4,148.8	64.39%
Operating	151	Other Basic Organic Chemical Manufacturing (Methanol)	578.4	8.98%
Operating	150	Other Basic Inorganic Chemical Manufacturing (Catalyst)	371.8	5.77%
Operating	394	Truck Transportation (Freight)	260.3	4.04%
Operating	28	Support Activities for oil and gas operations (FFA treatment)	302.2	4.69%
Operating	31	Heat energy	665.8	10.33%
Operating	30	Electricity	2.2	0.03%
Operating	485	Maintenance	114.1	1.77%
Depreciation	37	Manufacturing and Industrial Buildings (Building)	39.7	6.13%
Depreciation	239	Metal Tank, Heavy Gauge, Manufacturing (Storage Tanks)	96.0	14.83%
Depreciation	292	Conveyor & Conveying Equipment Manufacturing (Transesterfication Machinery)	511.5	79.04%
Byproduct	151	Glycerin	1,432.9	-

Table A.9. continued.

Type	IMPLAN Sector	IMPLAN Sector Description	Expenditures ($2005)
Value-Added	5001	Employee Compensation	6,924.32
Value-Added	6001	Proprietary Income	149.70
Value-Added	7001	Other Property Income	3,069.40
Value-Added	8001	Indirect Business Tax	142.17
Employees	20001	Employees[a]	0.1

Source: Peterson, C. "Feasibility study for commercial production of biodiesel, University of Idaho"; Frazier Barnes and Associates, "Arkansas Biodiesel Pre-Feasibility Study"

APPENDIX B

Table B.1 Summary of State Renewable Portfolio Standards.

State	Initial year enacted	Final Target	Year due	Resource eligibility	Obligation to comply	Credit trading
Arizona	2001	15%	2025	Solar PV (at least 5% in 2001-2003 and 60% in 2004-2012), solar thermal, in-state landfill gas, wind, biomass	Utility	Yes
California	2002	20%	2017	Solar PV, solar thermal, wind, biomass, landfill gas, geothermal, fuel cells, tidal/ocean, wave/thermal	Investor owned utility; Municipal utility	No
Colorado	2004	10%	2015	Solar PV, wind, geothermal, biomass (includes landfill gas, wastewater by-products, and animal wastes), hydro (<= 10MW), fuel cells using eligible renewable resources	Investor owned utility; Utility; Rural electric cooperative	Yes
Connecticut	2003	10%	2010	Wind, solar PV, solar thermal, biomass, fuel cells, landfill gas, tidal/ocean, wave/thermal	Utility	Yes
Delaware	2005	10%	2019	Wind, solar PV, solar thermal, biomass, fuel cells, land fill gas, tidal/ocean, wave/thermal, geothermal	Retail Electricity Supplier	Yes
District of Columbia	2004	11%	2022	Wind, solar PV, solar thermal, biomass, fuel cells, tidal/ocean, wave/thermal, geothermal	Utility	Yes

Table B.1. continued.

State	Initial year enacted	Final Target	Year due	Resource eligibility	Obligation to comply	Credit trading
Hawaii	2004	20%	2020	Wind, solar PV, solar thermal, biomass, fuel cells, landfill gas, tidal/ocean, wave/thermal, geothermal.	Utility	No
Iowa	1991	105 MW		Wind, solar PV, solar thermal, biomass, fuel cells, tidal/ocean	Utility	No
Illinois	2005	25%	2017	Wind, solar PV, biomass, fuel cells	Utility	No
Maine	1997	10%	2017	Wind, solar PV, solar thermal, biomass, fuel cells, land fill gas, tidal/ocean, wave/thermal	Utility	Yes
Maryland	2004	7.5%	2019	Wind, solar PV, solar thermal, biomass, fuel cells, land fill gas, tidal/ocean, wave/thermal, geothermal	Electricity supplier	Yes
Massachusetts	1997	4%	2009	Wind, solar PV, solar thermal, biomass, land fill gas, tidal/ocean, wave/thermal	Utility	Yes
Minnesota	2001	25%	2025	Wind and biomass with preference for in-state projects	Xcel only	No
Montana	2005	15%	2015	Wind, solar PV, solar thermal, biomass, fuel cells, land fill gas, tidal/ocean, geothermal	Utility	Yes
Nevada	2001	20%	2015	Wind, solar PV, solar thermal, biomass, fuel cells, tidal/ocean, geothermal. At least 5% of each year's standard must come from solar.	Investor owned utility	Yes
New Jersey	1999	6.5%	2008	Wind, solar PV, biomass, fuel cells, land fill gas, tidal/ocean, wave/thermal, geothermal	Utility	Yes

Table B.1. continued.

State	Initial year enacted	Final Target	Year due	Resource eligibility	Obligation to comply	Credit trading
New Mexico	2002	20%	2020	Wind, solar PV, solar thermal, biomass, fuel cells, land fill gas, tidal/ocean, geothermal	Investor owned utility	Yes
New York	2004	24%	2013	Wind, solar PV, biomass, fuel cells, land fill gas, tidal/ocean, wave/thermal	Investor owned utility	Yes
Pennsylvania	2004	18%	2020	Wind, solar PV, solar thermal, biomass, fuel cells, land fill gas, tidal/ocean, geothermal	Utility	Yes
Rhode Island	2004	15%	2020	Wind, solar PV, biomass, land fill gas, tidal/ocean, wave/thermal, geothermal, small hydroelectric	Electric retailers	Yes
Texas	1999	5,880 MW	2015	Wind, solar PV, solar thermal, biomass, fuel cells, tidal/ocean, wave/thermal, geothermal	Retail supplier	Yes
Vermont*	2005	10%	2013	Wind, solar PV, solar thermal, biomass, fuel cells, land fill gas, tidal/ocean	Retail electricity supplier	Yes
Wisconsin	1999	2.2%	2011	Wind, solar PV, solar thermal, biomass, fuel cells, land fill gas, tidal/ocean, wave/thermal, geothermal	Utility	Yes
Washington	2006	15%	2020	Solar thermal, PV, wind, biomass, alternative fuels, fuel cells, landfill gas, geothermal	Utility	Yes

Source: U.S. Department of Energy, Energy Efficiency and Renewable Energy. 2007. *States with Renewable Portfolio Standards*. Washington DC; Rabe, B. 2006. "Race to the Top: The Expanding Role of U.S. State RPS".

Table B.2 State Renewable Fuels Standards.

State	Level	Year due	Source	Enacted
Hawaii	E10	2006	Ethanol	Yes
Montana	E10	When state achieves minimal production level	Ethanol	Yes
Minnesota	E20	2013	Ethanol	Yes
Washington	E2 (in future E10)	December, 1, 2008	Ethanol	Yes
	B2 (in future B5)	November, 30, 2008	Biodiesel	
Illinois	10% of total sales 15% of total sales	2008 2012	Ethanol	Yes (passed Senate, not House for action)
California	B2 B5	2008 2010	Biodiesel	Yes
Iowa	10% of sales (E85) 25% of sales (E85)	2009 2020	Ethanol	Yes
Idaho	E10		Ethanol	Yes
Louisiana	E2	When state achieves min. production level	Ethanol	Yes
	B2		Biodiesel	
Colorado	E10 E20	2009 2013	Ethanol	No
Kansas	E10 B2	2010	Ethanol Biodiesel	No
Missouri	E10	2010	Ethanol	No
New Mexico	E10 B2	2009	Ethanol Biodiesel	No

Source: Green Car Congress, 2006; Legislature of the State of Idaho, 2006.

APPENDIX C

Table C.1. Top Ten Sectors Impacted Under the 5.16% Scenario, Total Value Added.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	368,830,208
78	Co-fire production	14,890,498
394	Truck transportation	12,551,865
41	Other new construction	841,061
425	Nondepository credit intermediation	709,091
439	Architectural and engineering services	238,057
292	Conveyor and conveying equipment manufacturing	168,255
316	Industrial process variable instruments	54,872
346	Motor vehicle body manufacturing	30,528
298	Industrial process furnace and oven manufacturing	16,883
	Indirect	
10	All other crop farming	34,269,932
425	Nondepository credit intermediation	13,444,762
407	Gasoline stations	8,647,599
485	Commercial machinery repair and maintenance	8,066,567
14	Logging	5,192,021
41	Other new construction	3,598,040
390	Wholesale trade	3,283,196
18	Agriculture and forestry support activities	2,729,049
112	Sawmills	2,142,378
431	Real Estate	1,899,912
	Induced	
503	State & Local Education	20,397,483
504	State & Local Non-Education	16,991,663
509	Owner-occupied dwellings	17,037,490
390	Wholesale trade	12,831,141
431	Real estate	10,645,596
465	Offices of physicians- dentists- and other health	8,988,672
38	Commercial and institutional buildings	6,622,045
33	New residential 1-unit structures- nonfarm	6,542,945
467	Hospitals	5,918,541
481	Food services and drinking places	5,753,177

Table C.2. Top Ten Sectors Impacted Under the 5.16% Scenario, Total Industry Output.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	494,862,976
78	Co-fire production	108,444,152
394	Truck transportation	25,009,854
41	Other new construction	2,039,078
425	Nondepository credit intermediation	873,404
292	Conveyor and conveying equipment manufacturing	477,623
439	Architectural and engineering services	391,746
316	Industrial process variable instruments	163,013
346	Motor vehicle body manufacturing	110,642
232	Prefabricated metal buildings and components	48,747
	Indirect	
10	All other crop farming	52,055,362
425	Nondepository credit intermediation	16,560,212
485	Commercial machinery repair and maintenance	16,277,054
14	Logging	11,788,138
407	Gasoline stations	11,443,100
112	Sawmills	9,374,094
41	Other new construction	8,723,126
390	Wholesale trade	4,316,655
394	Truck transportation	4,034,406
431	Real Estate	3,825,096
	Induced	
503	State & Local Education	18,081,546
33	New residential 1-unit structures- nonfarm	15,566,348
509	Owner-occupied dwellings	15,274,131
504	State & Local Non-Education	15,062,426
390	Wholesale trade	13,070,991
431	Real estate	12,038,685
38	Commercial and institutional buildings	11,968,464
344	Automobile and light truck manufacturing	9,345,096
481	Food services and drinking places	8,872,029
465	Offices of physicians- dentists- and other health	8,413,345

Table C.3. Top Ten Sectors Impacted Under the 5.16% Scenario, Employment.

IMPLAN Sector	Sector Description	Number of Jobs
	Direct	
78	Co-fire production	762.00
394	Truck transportation	227.00
90	Co-fire conversion	49.00
41	Other new construction	18.94
425	Nondepository credit intermediation	5.70
439	Architectural and engineering services	3.88
292	Conveyor and conveying equipment manufacturing	2.05
316	Industrial process variable instruments	0.80
346	Motor vehicle body manufacturing	0.44
232	Prefabricated metal buildings and components	0.27
	Indirect	
10	All other crop farming	1,134.93
407	Gasoline stations	234.44
18	Agriculture and forestry support activities	165.05
485	Commercial machinery repair and maintenance	135.16
425	Nondepository credit intermediation	108.14
41	Other new construction	81.03
14	Logging	50.34
112	Sawmills	41.26
394	Truck transportation	36.62
390	Wholesale trade	32.24
	Induced	
503	State & Local Education	420.24
504	State & Local Non-Education	300.37
481	Food services and drinking places	184.91
38	Commercial and institutional buildings	148.38
33	New residential 1-unit structures- nonfarm	99.34
390	Wholesale trade	97.64
431	Real estate	76.29
467	Hospitals	75.87
465	Offices of physicians- dentists- and other health	66.78
410	General merchandise stores	61.15

Table C.4. Top Ten Sectors Impacted Under the 8%(a) Scenario, Total Value Added.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire Conversion	368,830,208
78	Co-fire production	14,890,498
394	Truck transportation	12,551,865
41	Other new construction	841,061
425	Nondepository credit intermediation and related a	709,091
439	Architectural and engineering services	238,057
292	Conveyor and conveying equipment manufacturing	168,255
316	Industrial process variable instruments	54,872
346	Motor vehicle body manufacturing	30,528
298	Industrial process furnace and oven manufacturing	16,883
	Indirect	
451	Management of companies and enterprises	10,081,506
390	Wholesale trade	8,452,169
10	All other crop farming	7,056,285
390	Wholesale trade	6,905,877
441	Custom computer programming services	5,076,365
436	Lessors of nonfinancial intangible assets	2,499,945
91	Other tobacco product manufacturing	2,429,756
437	Legal services	2,349,442
430	Monetary authorities and depository credit	2,037,600
394	Truck transportation	1,649,867
	Induced	
503	State & Local Education	18,322,838
504	State & Local Non-Education	15,263,429
509	Owner-occupied dwellings	13,365,588
390	Wholesale trade	10,465,753
431	Real estate	8,696,146
465	Offices of physicians- dentists- and other health	7,085,738
38	Commercial and institutional buildings	5,779,164
33	New residential 1-unit structures	5,672,171
467	Hospitals	4,686,893
481	Food services and drinking places	4,559,686

Table C.5. Top Ten Sectors Impacted Under the 8%(a) Scenario, Total Industry Output.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	494,862,976
78	Co-fire production	108,444,152
394	Truck transportation	25,009,854
41	Other new construction	2,039,078
425	Nondepository credit intermediation and related a	873,404
292	Conveyor and conveying equipment manufacturing	477,623
439	Architectural and engineering services	391,746
316	Industrial process variable instruments	163,013
346	Motor vehicle body manufacturing	110,642
232	Prefabricated metal buildings and components	48,747
	Indirect	
451	Management of companies and enterprises	18,182,966
390	Wholesale trade	11,112,677
10	All other crop farming	10,718,360
390	Wholesale trade	9,079,656
441	Custom computer programming services	6,445,757
91	Other tobacco product manufacturing	5,076,734
436	Lessors of nonfinancial intangible assets	4,787,414
437	Legal services	3,464,073
394	Truck transportation	3,287,394
89	Tobacco stemming and redrying	2,970,039
	Induced	
503	State & Local Education	18,322,842
509	Owner-occupied dwellings	16,719,149
504	State & Local Non-Education	15,263,433
33	New residential 1-unit structures	15,181,486
390	Wholesale trade	13,760,083
431	Real estate	12,644,590
38	Commercial and institutional buildings	11,756,623
481	Food services and drinking places	9,632,631
344	Automobile and light truck manufacturing	9,299,830
465	Offices of physicians- dentists- and other health	9,156,732

Table C.6. Top Ten Sectors Impacted Under the 8%(a) Scenario, Employment.

IMPLAN Sector	Sector Description	Number of Jobs
	Direct	
78	Co-fire production	762.00
394	Truck transportation	227.00
90	Co-fire conversion	49.00
41	Other new construction	18.94
425	Nondepository credit intermediation	5.70
439	Architectural and engineering services	3.88
292	Conveyor and conveying equipment manufacturing	2.05
316	Industrial process variable instruments	0.80
346	Motor vehicle body manufacturing	0.44
232	Prefabricated metal buildings and components	0.27
	Indirect	
10	All other crop farming	991.41
407	Gasoline stations	233.73
10	All other crop farming	143.49
18	Agriculture and forestry support activities	118.87
425	Nondepository credit intermediation	104.17
41	Other new construction	81.03
485	Commercial machinery repair and maintenance	71.54
485	Commercial machinery repair and maintenance	63.29
14	Logging	50.30
18	Agriculture and forestry support activities	46.16
	Induced	
503	State & Local Education	420.23
504	State & Local Non-Education	300.36
481	Food services and drinking places	184.89
38	Commercial and institutional buildings	148.37
33	New residential 1-unit structures	99.34
390	Wholesale trade	97.63
431	Real estate	76.29
467	Hospitals	75.87
465	Offices of physicians- dentists- and other health	66.78
410	General merchandise stores	61.15

Table C.7. Top Ten Sectors Impacted Under the 10%(a) Scenario, Total Value Added.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	368,830,208
78	Co-fire production	14,890,498
394	Truck transportation	12,551,865
41	Other new construction	841,061
425	Nondepository credit intermediation and related a	709,091
439	Architectural and engineering services	238,057
292	Conveyor and conveying equipment manufacturing	168,255
316	Industrial process variable instruments	54,872
346	Motor vehicle body manufacturing	30,528
298	Industrial process furnace and oven manufacturing	16,883
	Indirect	
451	Management of companies and enterprises	10,081,500
390	Wholesale trade	8,452,149
10	All other crop farming	7,056,285
390	Wholesale trade	6,905,863
441	Custom computer programming services	5,076,365
436	Lessors of nonfinancial intangible assets	2,499,946
91	Other tobacco product manufacturing	2,429,756
437	Legal services	2,349,393
430	Monetary authorities and depository credit	2,037,603
394	Truck transportation	1,649,868
	Induced	
503	State & Local Education	18,322,806
504	State & Local Non-Education	15,263,401
509	Owner-occupied dwellings	13,365,622
390	Wholesale trade	10,465,733
431	Real estate	8,696,150
465	Offices of physicians- dentists- and other health	7,085,752
38	Commercial and institutional buildings	5,779,108
33	New residential 1-unit structures	5,672,106
467	Hospitals	4,686,899
481	Food services and drinking places	4,559,708

Table C.8. Top Ten Sectors Impacted Under the 10%(a) Scenario, Total Industry Output.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	494,862,976
78	Co-fire production	108,444,152
394	Truck transportation	25,009,854
41	Other new construction	2,039,078
425	Nondepository credit intermediation and related a	873,404
292	Conveyor and conveying equipment manufacturing	477,623
439	Architectural and engineering services	391,746
316	Industrial process variable instruments	163,013
346	Motor vehicle body manufacturing	110,642
232	Prefabricated metal buildings and components	48,747
	Indirect	
451	Management of companies and enterprises	18,182,956
390	Wholesale trade	11,112,652
10	All other crop farming	10,718,360
390	Wholesale trade	9,079,637
441	Custom computer programming services	6,445,757
91	Other tobacco product manufacturing	5,076,734
436	Lessors of nonfinancial intangible assets	4,787,414
437	Legal services	3,464,000
394	Truck transportation	3,287,397
89	Tobacco stemming and redrying	2,970,039
	Induced	
503	State & Local Education	18,322,810
509	Owner-occupied dwellings	16,719,191
504	State & Local Non-Education	15,263,405
33	New residential 1-unit structures	15,181,312
390	Wholesale trade	13,760,057
431	Real estate	12,644,595
38	Commercial and institutional buildings	11,756,509
481	Food services and drinking places	9,632,678
344	Automobile and light truck manufacturing	9,299,747
465	Offices of physicians- dentists- and other health	9,156,750

Table C.9. Top Ten Sectors Impacted Under the 10%(a) Scenario, Employment.

IMPLAN Sector	Sector Description	Number of Jobs
	Direct	
78	Co-fire production	762.00
394	Truck transportation	227.00
90	Co-fire conversion	49.00
41	Other new construction	18.94
425	Nondepository credit intermediation	5.70
439	Architectural and engineering services	3.88
292	Conveyor and conveying equipment manufacturing	2.05
316	Industrial process variable instruments	0.80
346	Motor vehicle body manufacturing	0.44
232	Prefabricated metal buildings and components	0.27
	Indirect	
10	All other crop farming	991.41
407	Gasoline stations	233.73
10	All other crop farming	143.49
18	Agriculture and forestry support activities	118.87
425	Nondepository credit intermediation	104.17
41	Other new construction	81.03
485	Commercial machinery repair and maintenance	71.54
485	Commercial machinery repair and maintenance	63.29
14	Logging	50.30
18	Agriculture and forestry support activities	46.16
	Induced	
503	State & Local Education	420.23
504	State & Local Non-Education	300.36
481	Food services and drinking places	184.88
38	Commercial and institutional buildings	148.37
33	New residential 1-unit structures	99.34
390	Wholesale trade	97.63
431	Real estate	76.28
467	Hospitals	75.87
465	Offices of physicians- dentists- and other health	66.78
410	General merchandise stores	61.15

Table C.10. Top Ten Sectors Impacted Under the 8%(b) Scenario, Total Value Added.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	368,830,208
78	Co-fire production	14,890,498
26	Biodiesel	13,661,407
394	Truck transportation	12,551,865
71	Seafood product preparation and packaging	10,662,755
425	Nondepository credit intermediation and related a	9,664,213
451	Management of companies and enterprises	8,941,147
37	Manufacturing and industrial buildings	4,688,086
292	Conveyor and conveying equipment manufacturing	4,362,188
335	Switchgear and switchboard apparatus manufacturing	3,746,193
	Indirect	
451	Management of companies and enterprises	10,068,114
390	Wholesale trade	8,444,308
10	All other crop farming	7,056,277
390	Wholesale trade	6,898,281
441	Custom computer programming services	5,076,326
394	Truck transportation	2,761,560
390	Wholesale trade	2,678,224
436	Lessors of nonfinancial intangible assets	2,499,912
91	Other tobacco product manufacturing	2,429,756
437	Legal services	2,348,724
	Induced	
503	State & Local Education	18,317,412
504	State & Local Non-Education	15,258,906
509	Owner-occupied dwellings	13,359,680
390	Wholesale trade	10,450,677
431	Real estate	8,691,706
465	Offices of physicians- dentists- and other health	7,082,591
38	Commercial and institutional buildings	5,776,387
33	New residential 1-unit structures	5,669,198
467	Hospitals	4,684,782
481	Food services and drinking places	4,557,671

Table C.11. Top Ten Sectors Impacted Under the 8%(b) Scenario, Total Industry Output.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	494,862,976
78	Co-fire production	108,444,152
26	Biodiesel	71,837,880
394	Truck transportation	25,009,854
311	Semiconductors and related device manufacturing	22,176,272
71	Seafood product preparation and packaging	19,380,738
285	Turbine and turbine generator set units manufacturing	17,985,512
451	Management of companies and enterprises	16,126,218
292	Conveyor and conveying equipment manufacturing	12,382,887
425	Nondepository credit intermediation and related a	11,903,625
	Indirect	
451	Management of companies and enterprises	18,158,812
390	Wholesale trade	11,102,343
10	All other crop farming	10,718,347
390	Wholesale trade	9,069,669
441	Custom computer programming services	6,445,707
394	Truck transportation	5,502,465
91	Other tobacco product manufacturing	5,076,734
436	Lessors of nonfinancial intangible assets	4,787,349
390	Wholesale trade	3,521,255
437	Legal services	3,463,014
	Induced	
503	State & Local Education	18,317,418
509	Owner-occupied dwellings	16,711,758
504	State & Local Non-Education	15,258,910
33	New residential 1-unit structures	15,173,531
390	Wholesale trade	13,740,262
431	Real estate	12,638,134
38	Commercial and institutional buildings	11,750,972
481	Food services and drinking places	9,628,375
344	Automobile and light truck manufacturing	9,294,546
465	Offices of physicians- dentists- and other health	9,152,664

Table C.12. Top Ten Sectors Impacted Under the 8%(b) Scenario, Employment.

IMPLAN Sector	Sector Description	Number of Jobs
	Direct	
78	Co-fire production	762.00
394	Truck transportation	227.00
37	Manufacturing and industrial buildings	108.32
451	Management of companies and enterprises	108.21
37	Manufacturing and industrial buildings	81.64
425	Nondepository credit intermediation	77.73
292	Conveyor and conveying equipment manufacturing	53.19
311	Semiconductors and related device manufacturing	51.99
90	Cigarette manufacturing	49.00
45	Other maintenance and repair construction	33.53
	Indirect	
10	All other crop farming	960.01
1	Oilseed farming	685.59
407	Gasoline stations	233.73
18	Agriculture and forestry support activities	115.77
425	Nondepository credit intermediation and related a	104.15
10	All other crop farming	99.59
41	Other new construction	81.03
485	Commercial machinery repair and maintenance	71.54
485	Commercial machinery repair and maintenance	63.27
14	Logging	50.04
	Induced	
503	State & Local Education	419.51
504	State & Local Non-Education	299.85
481	Food services and drinking places	184.40
38	Commercial and institutional buildings	147.93
33	New residential 1-unit structures	99.02
390	Wholesale trade	97.35
431	Real estate	76.07
467	Hospitals	75.66
465	Offices of physicians- dentists- and other health	66.59
410	General merchandise stores	60.98

Table C.13. Top Ten Sectors Impacted Under the 10%(b) Scenario, Total Value Added.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	368,830,208
78	Co-fire production	14,890,498
26	Biodiesel	13,661,407
394	Truck transportation	12,551,865
71	Seafood product preparation and packaging	10,662,755
425	Nondepository credit intermediation and related a	9,664,213
451	Management of companies and enterprises	8,941,147
37	Manufacturing and industrial buildings	4,688,086
292	Conveyor and conveying equipment manufacturing	4,362,188
335	Switchgear and switchboard apparatus manufacturing	3,746,193
	Indirect	
451	Management of companies and enterprises	10,068,126
390	Wholesale trade	8,446,419
10	All other crop farming	7,056,285
390	Wholesale trade	6,900,047
441	Custom computer programming services	5,076,330
394	Truck transportation	2,761,572
390	Wholesale trade	2,678,912
436	Lessors of nonfinancial intangible assets	2,499,914
91	Other tobacco product manufacturing	2,429,756
437	Legal services	2,348,762
	Induced	
503	State & Local Education	18,319,480
504	State & Local Non-Education	15,260,628
509	Owner-occupied dwellings	13,362,421
390	Wholesale trade	10,455,887
431	Real estate	8,693,812
465	Offices of physicians- dentists- and other health	7,084,084
38	Commercial and institutional buildings	5,778,189
33	New residential 1-unit structures	5,671,233
467	Hospitals	4,685,815
481	Food services and drinking places	4,558,628

Table C.14. Top Ten Sectors Impacted Under the 10%(b) Scenario, Total Industry Output.

IMPLAN Sector	Sector Description	Impacts, $
	Direct	
90	Co-fire conversion	494,862,976
78	Co-fire production	108,444,152
26	Biodiesel	71,837,880
394	Truck transportation	25,009,854
311	Semiconductors and related device manufacturing	22,176,272
71	Seafood product preparation and packaging	19,380,738
285	Turbine and turbine generator set units	17,985,512
451	Management of companies and enterprises	16,126,218
292	Conveyor and conveying equipment manufacturing	12,382,887
425	Nondepository credit intermediation	11,903,625
	Indirect	
451	Management of companies and enterprises	18,158,832
390	Wholesale trade	11,105,119
10	All other crop farming	10,718,359
390	Wholesale trade	9,071,991
441	Custom computer programming services	6,445,713
394	Truck transportation	5,502,490
91	Other tobacco product manufacturing	5,076,734
436	Lessors of nonfinancial intangible assets	4,787,353
390	Wholesale trade	3,522,159
437	Legal services	3,463,070
	Induced	
503	State & Local Education	18,319,484
509	Owner-occupied dwellings	16,715,187
504	State & Local Non-Education	15,260,632
33	New residential 1-unit structures	15,178,977
390	Wholesale trade	13,747,112
431	Real estate	12,641,195
38	Commercial and institutional buildings	11,754,639
481	Food services and drinking places	9,630,397
344	Automobile and light truck manufacturing	9,297,624
465	Offices of physicians- dentists- and other health	9,154,595

Table C.15. Top Ten Sectors Impacted Under the 10%(b) Scenario, Employment.

IMPLAN Sector	Sector Description	Number of Jobs
	Direct	
78	Co-fire production	762.00
394	Truck transportation	227.00
37	Manufacturing and industrial buildings	108.32
451	Management of companies and enterprises	108.21
37	Manufacturing and industrial buildings	81.64
425	Nondepository credit intermediation	77.73
292	Conveyor and conveying equipment manufacturing	53.19
311	Semiconductors and related device manufacturing	51.99
90	Cigarette manufacturing	49.00
45	Other maintenance and repair construction	33.53
	Indirect	
10	All other crop farming	960.01
1	Oilseed farming	685.59
407	Gasoline stations	233.73
18	Agriculture and forestry support activities	115.77
425	Nondepository credit intermediation	104.15
10	All other crop farming	99.59
41	Other new construction	81.03
485	Commercial machinery repair and maintenance	71.54
485	Commercial machinery repair and maintenance	63.27
14	Logging	50.04
	Induced	
503	State & Local Education	419.49
504	State & Local Non-Education	299.83
481	Food services and drinking places	184.37
38	Commercial and institutional buildings	147.91
33	New residential 1-unit structures	99.00
390	Wholesale trade	97.34
431	Real estate	76.06
467	Hospitals	75.65
465	Offices of physicians- dentists- and other health	66.59
410	General merchandise stores	60.97

Table C.16. Top Ten Sectors Impacted Under the RFS Scenario, Total Value Added.

IMPLAN Sector	Sector Description	Number of Jobs
	Direct	
50	Ethanol	37,289,116
26	Biodiesel	13,536,041
269	All other industrial machinery manufacturing	11,891,589
292	Conveyor and conveying equipment manufacturing	4,362,188
37	Manufacturing and industrial buildings	3,533,619
239	Metal tank- heavy gauge- manufacturing	2,603,218
150	Other basic inorganic chemical manufacturing	2,536,016
239	Metal tank- heavy gauge- manufacturing	2,350,432
292	Conveyor and conveying equipment manufacturing	1,551,306
425	Nondepository credit intermediation	1,484,575
	Indirect	
390	Wholesale trade	9,295,881
1	Oilseed farming	7,850,776
2	Grain farming	3,646,038
394	Truck transportation	3,398,085
390	Wholesale trade	2,856,340
392	Rail transportation	2,824,143
400	Warehousing and storage	1,956,997
390	Wholesale trade	1,842,774
428	Insurance agencies- brokerages- and related	1,164,754
425	Nondepository credit intermediation	900,842
	Induced	
509	Owner-occupied dwellings	2,765,211
390	Wholesale trade	1,875,863
509	Owner-occupied dwellings	1,806,074
503	State & Local Education	1,770,077
509	Owner-occupied dwellings	1,566,402
431	Real estate	1,552,683
504	State & Local Non-Education	1,474,523
465	Offices of physicians- dentists- and other health	1,442,900
390	Wholesale trade	1,057,241
467	Hospitals	941,719

Table C.17. Top Ten Sectors Impacted Under the RFS Scenario, Total Industry Output.

IMPLAN Sector	Sector Description	Number of Jobs
	Direct	
50	Ethanol	128,749,272
26	Biodiesel	71,178,648
269	All other industrial machinery manufacturing	34,374,144
292	Conveyor and conveying equipment manufacturing	12,382,887
37	Manufacturing and industrial buildings	7,747,145
150	Other basic inorganic chemical manufacturing	7,427,980
239	Metal tank- heavy gauge- manufacturing	5,976,201
239	Metal tank- heavy gauge- manufacturing	5,395,880
292	Conveyor and conveying equipment manufacturing	4,403,672
269	All other industrial machinery manufacturing	3,166,962
	Indirect	
1	Oilseed farming	14,825,075
390	Wholesale trade	12,221,968
2	Grain farming	7,046,692
394	Truck transportation	6,770,755
392	Rail transportation	4,571,228
390	Wholesale trade	3,755,437
400	Warehousing and storage	2,613,076
390	Wholesale trade	2,422,829
495	Federal electric utilities	1,462,574
451	Management of companies and enterprises	1,326,997
	Induced	
509	Owner-occupied dwellings	3,459,030
390	Wholesale trade	2,466,333
509	Owner-occupied dwellings	2,259,237
431	Real estate	2,257,671
33	New residential 1-unit structures	2,221,214
509	Owner-occupied dwellings	1,959,427
481	Food services and drinking places	1,914,954
465	Offices of physicians- dentists- and other health	1,864,625
467	Hospitals	1,811,055
503	State & Local Education	1,770,077

Table C.18. Top Ten Sectors Impacted Under the RFS Scenario, Employment.

IMPLAN Sector	Sector Description	Number of Jobs
	Direct	
269	All other industrial machinery manufacturing	180.28
37	Manufacturing and industrial buildings	81.64
292	Conveyor and conveying equipment manufacturing	53.19
50	Ethanol	36.00
239	Metal tank- heavy gauge- manufacturing	35.74
239	Metal tank- heavy gauge- manufacturing	32.27
292	Conveyor and conveying equipment manufacturing	18.91
150	Other basic inorganic chemical manufacturing	18.12
26	Biodiesel	18.00
269	All other industrial machinery manufacturing	16.61
	Indirect	
1	Oilseed farming	679.35
2	Grain farming	490.21
390	Wholesale trade	91.29
394	Truck transportation	61.45
400	Warehousing and storage	34.76
390	Wholesale trade	28.05
392	Rail transportation	18.35
390	Wholesale trade	18.10
428	Insurance agencies- brokerages- and related	10.79
18	Agriculture and forestry support activities	10.65
	Induced	
503	State & Local Education	41.14
481	Food services and drinking places	39.91
504	State & Local Non-Education	29.40
481	Food services and drinking places	25.46
481	Food services and drinking places	22.13
38	Commercial and institutional buildings	19.95
390	Wholesale trade	18.42
467	Hospitals	16.49
503	State & Local Education	16.29
390	Wholesale trade	16.07

VITA

Kateryna Goychuk was born in Kiev, Ukraine on March 11, 1985. In September, 2001 she enrolled at National Agricultural University in Kiev. In 2003 she become a winner of the Freedom Support Act Undergraduate Program, sponsored by Bureau of Educational and Cultural Affairs of the United States Department of State and the American Council for International Education and was awarded a scholarship to study for one year at Alabama A&M University with specialization in Agribusiness. In June 2005 she graduated from National Agricultural University in Ukraine with two Bachelor of Science degrees in Finance and Plant Protection. In August, 2005 she accepted a research assistantship at the University of Tennessee, Knoxville, and began studying towards a Master of Science degree in Agricultural Economics. She received her degree in August, 2007.