SECTION 3: ENERGY EFFICIENCY PROGRAMS

3.1 Profile of Existing DSM Programs

Many of the studies of energy efficiency program impacts on other states have been based on hypothetical data concerning the program mix, market penetration and costs associated with these programs. This study starts by identifying the actual program mix, market penetration and costs associated with these programs occurring in Iowa as of 1994. This provides a solid basis for modeling the economic impacts of the current program activities, as well as a strong foundation for extrapolating these results to represent other possible future scenarios.

Information Needed.

In prior studies of the economic impacts of DSM and energy efficiency programs, there has been a dearth of information on the distribution of costs by spending category and type of program, as well as the distribution of benefits. Most often, the approach has been to assume that: (a) there is a constant pattern to DSM program costs regardless of program type or size, (b) program costs and benefits are equally or proportionally distributed among sectors of the economy, and (c) timing is not an issue. To avoid the pitfalls of such assumptions, three steps were taken.

1. An inventory and database of Iowa's energy efficiency programs, including information on program types, program costs, participation and program benefits, was assembled.

2. Detailed information on the distribution of program costs by different utilities for different types of programs was compiled, using data from filings with the Iowa Utilities Board and additional data provided directly by the individual utilities.

3. A profile of participants receiving financial incentives from Iowa DSM programs was estimated based on utility data and state economic data.

Methodology.

In order to obtain data on current energy efficiency programs, the project team undertook a two-stage process. The first stage involved working with the Iowa Utilities Board to identify all of the relevant utilities, agencies and programs, as presented in filings with the state. The large quantity of filed documents were then examined in order to extract simulation model data on program types, costs and expected benefits. This was then followed up with a survey of the utilities and agencies operating these programs. The survey covered the following areas:

1. List of current energy efficiency, conservation and load management programs

2. Categorization of each program by sector (commercial, industrial, agricultural, institutional, residential)

3. Categorization of each program by end use (heating, cooling, lighting, motors, process equipment)

4. Categorization of each program by type (new construction or retrofit)

5. Level of annual funding for each program.

6. Current annual participation level for each program.

7. Expected annual energy savings (kWh or therms) and peak savings in demand for each program

8. Method of program financing, and rate impact by sector

9. Pattern of program costs for each type of program , end-use and sector type (distinguishing administration, marketing, delivery/installation, subsidies/rebates paid, monitoring and evaluation)

10. Mix of in-state vs. out-of-state spending for program vendors, for each cost category cited above.

11. Characteristics of program participants.

Results: Statewide Profile of Programs

A summary of the inventory of Iowa DSM programs is shown in the Appendix. A total of 151 programs were identified. These included the following types of programs:

- Conservation programs -- insulation, weatherization, windows, setback thermostats

  - High efficiency equipment promotions and incentives -- appliances, motors, lighting, air conditioning, space heating, water heating, refrigeration, process equipment, street lighting,

- Load Control -- time of use rates, direct load control of air conditioners, interruptible/curtailable rates (these programs do not save energy, but they shift demand from high-cost peak periods to lower-cost off-peak periods).

- Special targeted sectors -- low income, small commercial, new construction, cogeneration, tree planting, farm, large industrial

- Methods -- audit programs, information programs, rebate programs, direct installation programs

- Fuels -- electric, natural gas

The sponsoring organizations, number of different program types and total 1994 funding are shown in Table 3.

Table 3: Programs and Spending Levels of Energy Efficiency and DSM Programs in Iowa

Company	# of Programs	1994 Spending
IES	11	$ 12.4 million
Interstate Power*	15	$ 6.9 million
Iowa - Illinois Gas & Electric*	16	$ 7.3 million
Iowa Dept. of Natural Resources*	1 (statewide)	$ 8.9 million
Midwest Gas	12	$ 6.4 million
Midwest Power*	34	$ 20.4 million
Municipal Utilities*	27	$ 8.4 million
People's Natural Gas	9	$ 1.8 million
Rural Electric Cooperatives	23 (types)	$ 3.4 million
Waverly Light & Power	1	$ 58.0 thousand
United Cities Gas*	2	$158.0 thousand
TOTAL	151 programs	$76.1 million

* denotes respondent providing program details; other detail from Iowa Utilities Board
Source: Survey of Iowa Utilities and the Iowa Utilities Board (IUB).

Overall, the completed database revealed the following attributes of DSM programs in Iowa (as of 1994):

- $76 million spent per year
- 225,743 participants

· 234 gWh annual electricity energy savings
· 10.8 million therms annual natural gas savings

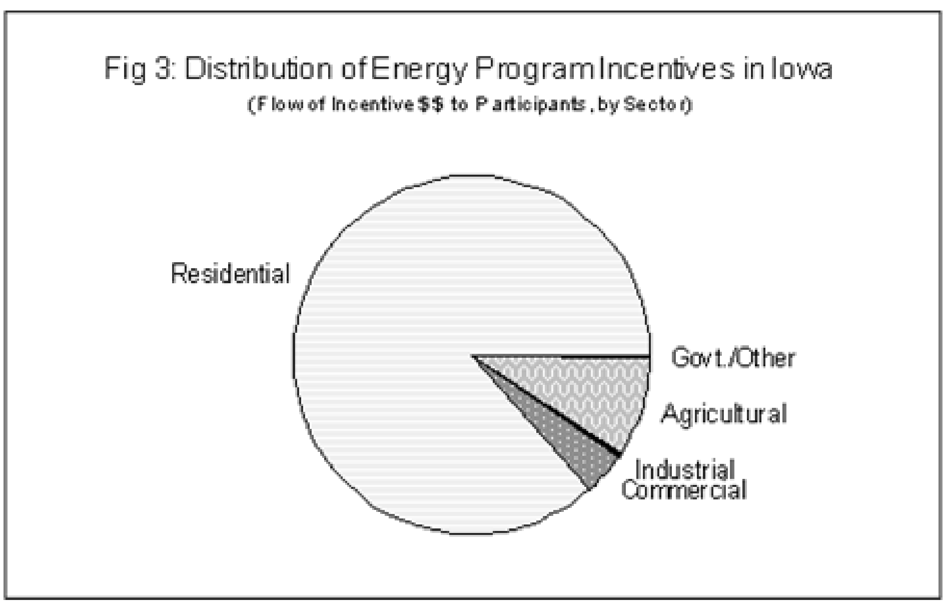
Results - Participation

The utilities supplied information on the mix of program recipients, among the commercial, industrial, agricultural, institutional and residential sectors. The overall breakdown of program spending, by type of recipient, is shown on Table 4 and Figure 3.

Table 4: Program Participation, Spending and Savings by Type of Participant, 1994

Sector	Participants/yr		Incentives/yr (Millions)		GWh Saved/yr		Therms Saved/yr (Millions)
Commercial	8,786	(3.8%)	$ 8.9m	(11.7%)	51	(21.6%)	3.9m (36.1%)
Industrial	1,099	(0.5%)	$ 3.4m	(4.5%)	23	(9.8%)	0.01m (0.01%)
Agriculture	20,275	(9.0%)	$ 1.5m	(12.4%)	7	(3.1%)	0
Instit/Govt	390	(0.2%)	$ 13.5m	(17.8%)	20	(8.7%)	0
Residential	195,193	(86.5%)	$ 48.5m	(64.0%)	133	(56.8%)	6.9m (63.8%)
	225,743	(100%)	$75.8m	(100%)	234	(100%)	10.m (100%)

*includes incentives administration and operations
Source: Survey of Iowa Utilities



Program Spending Pattern.

The estimated distribution of incentives from Iowa DSM programs (summarized in preceding Figure 3) indicates that some business sectors received a particularly large benefit of energy efficiency incentives. This is a function of the composition of businesses in the state, the DSM program mix, and the pattern of business response to DSM program offers. Other estimated breakdowns of program spending by end-use is 48% HVAC, 23% lighting, 14% hot water, 6% building shell, 4% new construction, and 5% motors and process equipment.

In addition, profiles were developed of program spending patterns for marketing, service delivery, incentives, monitoring & evaluation and quality control. The results, shown in Table 5 and Figure 4, indicate that the various elements of program cost vary significantly in magnitude and in relative size among different program types. In general, a majority of the program costs go for incentive payments (rebates), although there are exceptions. New construction programs have particularly high administrative costs, while residential lighting programs have particularly high promotional costs, when expressed as a percentage of total program costs.

TABLE 5: Breakdown of Costs for Iowa DSM Programs

Cost Category	Lighting	HVAC	New Const.	Proc.Equip.	Motors
Commercial & Industrial Programs					
Admin & Implement.	15%	21%	53%	24%	43%
Promotion	6%	8%	6%	7%	9%
Monit+Eval	12%	18%	3%	23%	17%
Incentives	67%	53%	38%	46%	31%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Cost Category	Lighting	HVAC	New Const.	Weatherization
Residential Programs				
Admin & Implement.	13%	10%	23%	8%
Promotion	33%	12%	6%	3%
Monit+Eval	5%	6%	18%	8%
Incentives	49%	72%	53%	81%
Total	**100%**	**100%**	**100%**	**100%**

Source: Survey of Iowa Utilities

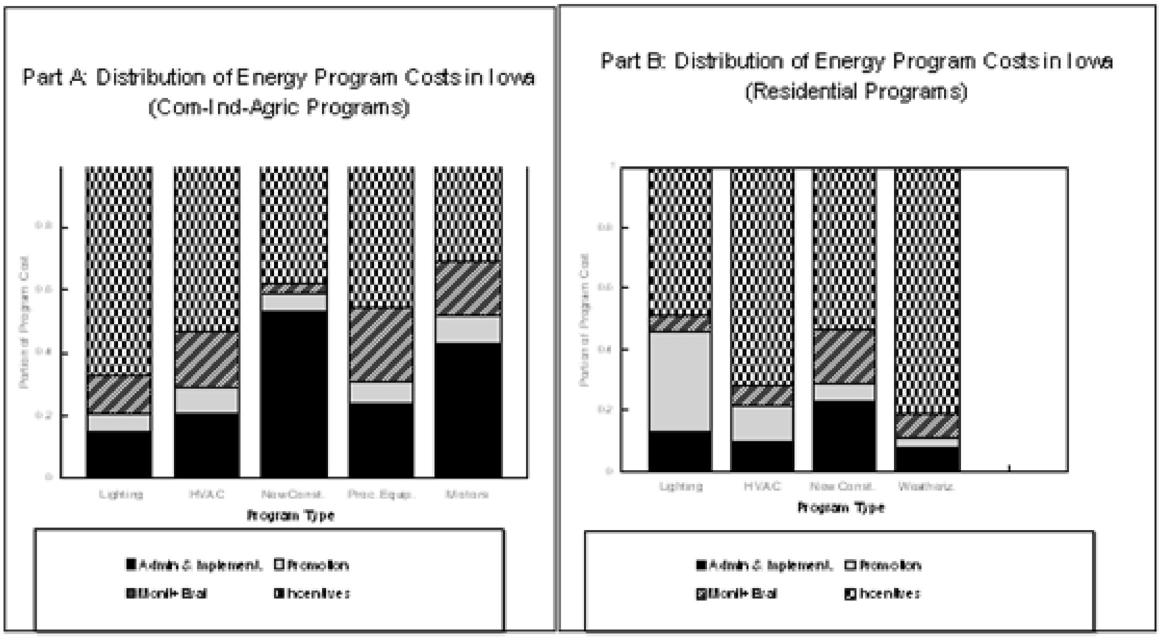


FIGURE 4: Breakdown of Costs for Iowa DSM Programs

In addition, profiles were developed of the frequency of in-house vs. use of vendors for program marketing, service delivery, monitoring & evaluation and quality control, as shown in Table 6. They show that Iowa firms are used for most program delivery and marketing, although 1/2 of the installation dollars and 4/5 of the monitoring & evaluation dollars flow to out-of-state specialists.

Table 6: Use of Vendors for Utility Programs

Type of Service	Percent In-House (no vendor)	Percent In-State Vendor	Percent Out-of-State Vendor	Total Percent
Program Delivery	10%	90%	0%	100%
Marketing	20%	80%	0%	100%
Monitoring & Eval.	0%	13%	82%	100%
Installation	0%	43%	57%	100%
Qual Control + Eng.	40%	27%	33%	100%

Source: Survey of Iowa Utilities

Uses of the Program Information.

The results described here provide the following important Iowa-specific data, for use in economic modeling for the State of Iowa:

- Determination of **program participant mix by economic sector** of recipient
- Determination of program **equipment mix** (and associated economic sector)
- Determination of program **costs per kWh and per therm**, by participant sector and end use type
- Determination of program **cost mix** by type of program (participant sector and end use type)
- Determination of **regional purchase coefficients** (in-state supply) for program implementation spending, by program cost element.

3.2 Survey of Iowa Manufacturers and Distributors

Information Needed

An important element of realistic and useful economic modeling is the use of appropriate values concerning flows of spending on energy efficiency programs -- specifically the portion of local spending on energy efficiency products and services which is supplied by locally-produced (in-state) manufacturers and service providers. In order to obtain this information, we conducted a study of the manufacturing and distribution of major energy-consuming products and the "high efficiency portion of their sales. The results were then used to adjust the economic model assumptions on spending flows for energy-saving equipment.

Survey Methodology

To study the above issues, a survey was conducted of Iowa businesses which manufacture or distribute major electricity-consuming equipment.

Survey Coverage. Types of businesses which were covered in the survey are shown in Table 7.

Table 7: SIC Codes of Surveyed Energy Product Manufacturers and Distributors

3585-99	Refrigeration and Heating Equipment
3612-02	Lamp Ballasts
3621	Motors and Generators
3631	Stoves and Ovens
3632	Refrigerators and Freezers
3633	Washers and Dryers
3641-01,02	Electric Lamps and Parts
3645-99	Residential Lighting Equipment
3646	Commercial, Industrial, and Institutional Lighting
3648-01	Outdoor Lighting Equipment
3585	Air Conditioning and Warm Air Heating Equipment (Com./
3822-01	Air Conditioning and Refrigerator Controls
Distributors	
5063-9	Electrical Apparatus and Equipment
5075	Warm Air Heating Equipment
5719-02	Lighting Equipment
5999-07	Engine and Motor Equipment and Supplies

Survey Content. The survey instrument is shown in Appendix A. It covered the following questions:

1. Types of products made, distributed, installed & repaired
2. Portion of #1 (above) which is "high efficiency" (as opposed to "standard efficiency")
3. Percentage of business sales revenue which is from in-state
4. Portion of in-state revenue (#3) and out-of-state revenue which is high efficiency
5. Wholesale or retail channels through which the products (#1) are sold.
6 Percentage of business spending on intermediate supplies and services which is from in-state
7. Knowledge of utility energy efficiency programs
8. Impact of utility energy efficiency programs on their business
9. Business sales and employment characteristics

Survey Mailing. Initially, Dun & Bradstreet's DMI (Duns Market Indicators) database was used to identify manufacturers and distributors located in the State of Iowa with 10 or more employees or $1 million or more sales revenue within the state. The Harris Directory of Iowa Manufacturers was used to supplement and cross-check that data. As a result, a total of 40 manufacturers and 100 distributors were identified.

A mail reply survey was sent to those businesses. A breakdown of these businesses, by type, is shown in Table 6.

Survey Results.

Of the 140 firms which were mailed surveys, 66 responded. Of those, nearly 25% (16 of the 66) had few or none of the questions filled out, and were accompanied with notes explaining that the firm was not really involved in business activity relevant to the survey. Most frequently, these were firms manufacturing or selling gasoline-powered automotive or marine motors, oil-fired boilers for specialized commercial or industrial processes, or other gasoline or oil-based equipment. In addition, three of the responses were received too late to be used. Thus, most of the results reported here are based on 47 fully-completed surveys. A breakdown of the surveys received is shown in Table 8.

Table 8: Profile of Surveys Sent Out and Received

	Sent Out (Census)*	Returned (Survey)
Manufacturers		
Space Heating and Air Conditioning	12	2
Lighting	4	3
Refrigeration	4	2
Motors	3	2
Controls & Misc. Appliances	15	4
Insulation	3	1
	40	14
Distributors		
Heating, Ventilation and Air Conditioning	51	18
General Electrical (Lighting, Motors, Controls)	49	15
	100	33

*businesses with at least 10 employees or $1 million revenue in Iowa
Source: Survey of Iowa Energy Product Manufacturers and Distributors

Product Mix

The Dun & Bradstreet DMI database and Harris Directory of Manufacturers, along with the survey results, showed that Iowa has a concentration of major national manufacturers of major household appliances -- washers, dryers, refrigerators and stoves. (See Table 8.) Iowa also has a major manufacturer of heating and cooling equipment, including heat pumps. On the other hand, Iowa has relatively little representation of lighting manufacturing.

This pattern is further illustrated by the distribution of survey responses on types of products manufactured and distributed in Iowa, as shown in Table 10. The results again show that among responding manufacturers, there is significant representation of refrigerators and refrigeration equipment products. Some other Iowa manufacturers reported producing lighting, space heating and cooling products, motors and ice machines. The state's distributors reported handling all of the above-listed equipment, as well as humidifiers, hot water heaters, transformers and controls, as well as insulation, and insulating windows.

Table 9: Largest Iowa Manufacturers of Electrical Products (ranked by Employment)

(Employing 1000 - 3500)		
Maytag Corporation	3632	Stoves, Refrigerators, Washers
Amana Refrigeration	3632	Refrigerators
Fisher Controls	3612	Lamp Ballasts & Controls
Lennox Industries	3585	Heating & Cooling Equipment
White Consolidated Industries	3633	Refrigerators
(Employing 100 - 999)		
Dexter Company	3632	Refrigeration
Burcliff Industrial	3585	Heating & Cooling Equipment
EMW Groschopp	3621	Motors
Frigidaire Company	3633	Refrigerators
G.E. Appliance Controls	3556	Electrical Controls
Musco Sports Lighting	3641	Lighting
Products United	3612	Ballasts
SNC Manufacturing	3612	Ballasts
IMI Cornelius	3585	Ice Makers

Source: Survey of Iowa Energy Product Manufacturers and Distributors

Table 10: Products Produced and Distributed by Survey Respondents

Product	Manufacturers	Distributors
Lighting Equipment	2	11
Cooking Equipment (Stoves, Ovens)	0	3
Refrigeration Equipment	3	3
Washing Machines	0	2
Heating Systems	1	9
Air Conditioners or Heat Pumps	2	12
Motors	3	13
Other Equipment		
Humidifiers	0	6
Hot Water Heaters	0	10
Transformers	0	8
Controls	0	12
Insulation	0	4
Windows	0	4
- Miscellaneous	1	7
TOTAL	12	103
(sample size reporting results)	(n=12)	(n=29)

Source: Survey of Iowa Energy Product Manufacturers and Distributors

High Efficiency Products

Manufacturing. Essentially, the survey responses showed reported sales of high efficiency products by Iowa manufacturers as concentrated in five product categories -- Air Conditioners and Heat Pumps (49% of sales of energy saving products), other HVAC Equipment and Controls (35%), Refrigerators and Freezers (11%), Motors (3%) and high efficiency ballasts (2%). The "other" category reflects sales of ice vending machines by one large company. None of the five major companies involved in lighting equipment manufacturing reported any sales of high efficiency lighting equipment, except for ballasts. The portion of total product sales which is high efficiency equipment (as defined by the respondent) averaged in the 50 - 80% range for the responding manufacturers of HVAC, refrigerators and motors. (See Table 11)

Distributors. Overall, sales of high efficiency products account for nearly one-third of total sales reported by electrical product wholesale distributors. The high efficiency portion of total distributor sales was highest for space heating and cooling equipment (in the 51 - 64% range), followed by refrigeration equipment (35%). The energy efficient portion was lowest for lighting (9%) and washing machines (0%). (See Table 11). In between was the distribution of high efficiency motors and controls.

Table 11: Percent of Products Which are High Efficiency

Product	Iowa Manufacturers mean (range)	Iowa Distributors mean (range)	
Lighting Equipment	0% (0%)	9%	(0 -100%)
Cooking Equipment (Stoves, Ovens)|	NA	16%	(0 - 50%)
Refrigeration Equipment	81%(70 - 100%)	35%	(0- 100%)
Washing Machines	NA	0%	(0%)
Heating Systems	60% (60%)	64%	(50 - 95%)
Air Conditioners or Heat Pumps	70% (60-100%)	51%	(0 - 100%)
Motors	58% (10-60%)	25%	(0 - 100%)
Other Equipment	NA		
Humidifiers		23%	(0- 100%)
Hot Water Heaters		25%	(0 - 70%)
Transformers		27%	(0 - 100%)
Controls		42%	(0 - 100%)
Insulation		5%	(0 - 20%)
Windows		22%	(0 - 90%)
Miscellaneous		NA	NA

Source: Survey of Iowa Energy Product Manufacturers and Distributors

Customers and Suppliers

Manufacturers. Iowa manufacturers reported a mix of customer types, with the largest portion of sales, 33%, being sold to direct contractors and installation companies. Twenty-four percent of sales go directly to retail businesses, while OEMS and wholesale distributors account for 15%, contractors account for 33% and GEMS and other sellers account of 28% account for a further 15%. (see Table 12) Only 10% of the manufactured products were sold to Iowa customers; the rest were located in other states. (See Table 13.) Iowa Manufacturers also obtain relatively little of their supplies from within the state (See Table 14).

Distributors. Iowa wholesale distributors reported that 55% of their sales are to contractors and installation companies, with another 14% sold to other wholesaler distributors and resellers. Retail customers and other end-users accounted for 30 percent of sales. In contrast to manufacturers, wholesale distributors in Iowa sell principally within the state. A reported 78% of distributor revenues were reported attributable to customers within Iowa. (See Table 13). However, distributors obtain most of their products from out-of-state manufacturers (See Table 14).

Table 12: Customers of Iowa -- Energy Product Manufacturers and Distributors

Customers	Manufacturers	Distributors	Install/Repair
Retail	24%	30%	--
Wholesalers	15%	5%	2%
Contractors	33%	55%	24%
OEMs & Resellers	28%	10%	1%
End Users	0%	0%	73%
	100%	100%	100%

Source: Survey of Iowa Energy Product Manufacturers and Distributors

Table 13: Percent of Final Products & Services Being Sold to In-State Buyers

	Manufacturers	Distributors	Repair Service
Mean Percentage	10%	78%	97%
Percentage of Respondents Reporting			
Relatively Little (0-10%)	82%	10%	0%
Less than Half (11-44%)	9%	0%	0%
About Half (45-55%)	9%	15%	0%
Most (56-89%)	0%	10%	0%
Nearly All (90-100%)	0%	65%	100%
	100%	100%	100%

Source: Survey of Iowa Energy Product Manufacturers and Distributors

Table 14: Percentage of Supplies (Intermediate Goods) Being Purchased from In-State Suppliers

	Manufacturers	Distributors	Repair Service
MEAN PERCENTAGE	5%	11%	64%
Percentage of respondents reporting			
Relatively Little (0-10%)	55%	80%	25%
Less than Half (11-44%)	45%	20%	25%
About Half (45-55%)	0%	0%	0%
Most (56-89%)	0%	0%	25%
Nearly All (90-100%)	0%	0%	25%

Source: Survey of Iowa Energy Product Manufacturers and Distributors

Impact of Utility Programs.

The manufacturers and distributors were also asked about their awareness of the DSM and energy efficiency programs operated by Iowa's utilities, and the impact that these programs had on their product offerings. The results, shown in Table 15, indicate that nearly all distributors and contractors are aware of the programs. A lesser level of familiarity was indicated by the manufacturers, which is to be expected given that most of their business is sales to outside areas. In addition, most of the manufacturers and distributors indicated that they normally carry high efficiency products anyway.

Table 15: Percentages Which Knew About Utility DSM Programs and Changed Product and Services Sold

	Manu-facturers	Distrib-utors	Repair	Overall
Heard of Utility Incentives and Grants				
Yes -- Knew details	42%	82%	100%	74%
Yes -- Knew of them (but not details)	42%	11%	0%	17%
No -- not aware of them	16%	7%	0%	9%
Products/Services Affected as a Result of Utility Incentives				
New energy efficient products introduced	17%	68%	20%	74%
Normally sell energy efficient products anyway	50%	27%	40%	18%
Considering introducing energy efficient products	0%	0%	0%	0%
No impact	33%	5%	40%	8%

Source: Survey of Iowa Energy Product Manufacturers and Distributors

Uses of the Business Survey Information.

The results described here provide the following important Iowa-specific data, for use in economic modeling for the State of Iowa:

- Equipment Regional Purchase Coefficients -- portion of high efficiency equipment sold in Iowa which is manufactured in Iowa

- Business Regional Purchase Coefficients -- portion of supplies purchased by Iowa manufacturers and service firms which come from in-state firms.

- Employment / Sales ratios for Iowa manufacturers and distributors of energy efficient equipment

- Capacity of Iowa Manufacturers & Distributors to benefit from alternative future energy efficiency programs (by equipment type)

3.3 Description of Potential Scenarios

The following alternative scenarios were defined:

1. Varying the level of spending and energy savings (high/low, rising/falling)

2 Shifting the program focus by customer sector (commercial, industrial and/or residential focus)

3. Shifting the mix of program activities by type of end-use measure (lighting, HVAC & electrical, equipment vs. Weatherization & building shell)

4. Shifting the mix of program activities (incentives, information activities)

5. These or other scenarios can also shift the overall cost-effectiveness and cost recovery (cost/savings ratio, cost recovery period, rate impact) of these programs.

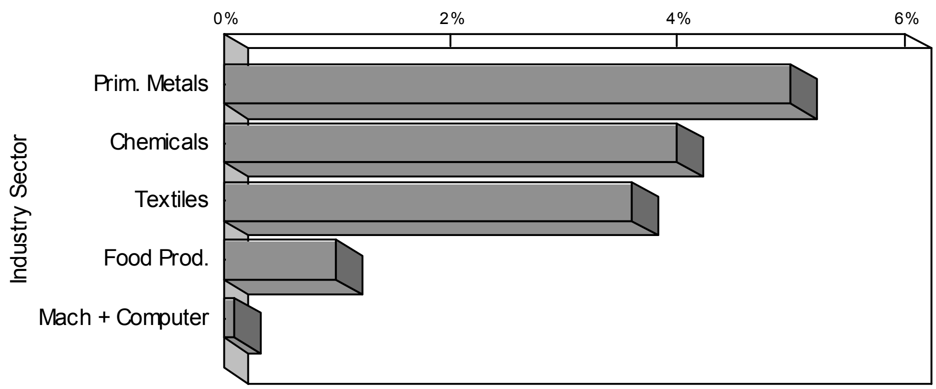
3.4 Construction of Model Parameters and Results for Scenarios

Local Business Competitiveness.

Energy costs affect the overall costs of doing business in Iowa. However, the impact of energy costs on various segments of Iowa's economy is **NOT** simply a function of the relative level of energy costs compared to elsewhere nor is it simply a function of the relative portion of total costs which energy represents. Rather, energy costs affect Iowa's economy insofar as the locations of certain types of businesses are more cost-sensitive than others, and an Iowa location is more cost competitive for some types of businesses than for others. Thus, it is important to examine the relative cost competitiveness of locating a business in Iowa to serve national markets, compared to locating the same type of business elsewhere.

Accordingly, the REMI model utilized historical data for 1972 - present on the cost competitiveness of doing business in Iowa relative to elsewhere in the U.S. (for each of 53 industries) and the growth of the Iowa economy relative to national growth (for each of those industries). Based on this information, estimates were developed of the impact of changes in the operating cost of business in Iowa on the growth of industries in the state. Figure 5 illustrates how businesses differ in their sensitivity to energy costs. It shows how the energy portion of overall business costs differs by industry.

Fig. 5: Energy Portion of Overall Business Costs by Industry



Construction of Scenarios

The following program scenarios are represented (see Table 16):

Table 16: ENERGY EFFICIENCY SCENARIOS

Scenario	Amount	Years	Sectors	Technologies
1.	$80m	1	All	All (current mix)
2.	$80m/yr	10	All	All (current mix)
3.	$80m/yr	10	Residential only	All (current mix)
4.	$80m/yr	10	All	Bldg. Shell & New Constr.
5.	$80m/yr	10	All	Lighting, Process, Appliance
6.	$80m/yr	10	All	HVAC & Water Heating
7.	$15m/yr	4	Residential	Low Income: Bldg. shell & Weatherization & Heating
8.	$80m phase down to $0	4	All	All (current mix)

Scenario 1 was designed to show the impact over time (i.e., the next ten years) resulting from one year of spending on energy efficiency programs at roughly current levels. (Revised calculations of current programs indicate a spending level $76.1 million down from initial estimates of $80 million. For purposes of modeling, a spending level of $80 million was assumed). Scenario 2 was designed to show the cumulative impact on the Iowa economy from ten years of program spending and an additional ten years of energy savings. Scenarios 3 - 6 represent variations on Scenario 2, in which the mix of energy efficiency programs is shifted to focus on particular customer sectors or particular types of end uses (equipment). Scenarios 7 - 8 represent “phase out” scenarios, in which energy efficiency programs are either cut down to just low income residential programs for four years or else phased out totally over four years. Of course, these scenarios are just meant to be illustrative examples. The template discussed in Section 5 is designed to allow estimation of impacts associated with other program mixes and spending levels.

All of the scenario variations are represented in the REMI model by the following set of factors:

Demand Factors (Effect of Program Spending)
Increased demand for purchases of electric equipment & gas appliances
Increased demand for purchases of building and insulation materials
Increased demand for purchases of installation & engineering services
Reduction in demand for electricity and gas

Relative Cost Factors (Effect of Energy Savings and Price Changes)
Shift in Residential disposable income (reduced by initial co-payment and rate impact, increased by energy savings over time)
Shift in commercial business operating cost (reduced by energy savings and increased by co-payment and rate increase impacts)
Shift in industrial business operating cost (reduced by energy savings and increased by co-payment and rate increase impacts)

The demand factors are directly sensitive to the types of technologies being installed, and also vary systematically by economic sector. The cost factors are directly sensitive to the target sectors and also vary systematically by type of technology.

3.5 Results for Alternative Scenarios

Results for a one-time spending of $80 million -- the first scenario -- is shown in Table 17. It shows that a one-time $80 million campaign leads to the creation of accumulated 2029 job-years, $144 million of increased disposable income in the state and $80 million increase in Gross State Product (GSP) spread over the subsequent decade. (Note that GSP, which represents state value added, rises less than income because of the import substitution effect. That occurs insofar as some of the added personal income is associated with in-state production of products which had previously been purchased from out-of-state suppliers. That represents a relocation of employment and associated personal income from out-of-state to in-state; but it does not necessarily represent any net gain in business value -- which is sales revenue minus costs - for Iowa businesses. Overall, 25 job-years of employment are added and $1.8 million of additional disposable income are created per million dollars of spending. (That represents a relocation of employment and associated personal income from out-of-state, but it does not necessarily represent any net gain in business value added--which is sales revenue minus costs for long businesses.)

Table 17: Economic Impacts of $80m Spending on of Energy Efficiency

Programs in State of Iowa

	Absolute Amount	Ratio: Per Dollar Spent	Percent Increase Over State Total
Spending			
Total Over 10 yrs	$800m	n.a.	n.a.
Average Year	$80 m	n.a.	n.a.
Peak Year	$80 m	n.a.	n.a.
Net Present Value*	$80 m	n.a.	n.a.
Change in Jobs			
Total Over 10 yrs (Job-yrs)	2,029	2.5	0.008%
Average Year	203	2.5	0.008%
Peak Year	301	4.0	0.013%
Net Present Value*	1,561	2.0	0.008%
Change in Disposable Income			
(millions of constant 1994 $)			
Total Over 10 yrs	$144m	$2.0	0.010%
Average Year	$14m	$0.2	0.010%
Peak Year	$21m	$0.3	0.020%
Net Present Value*	$109m	$1.4	0.010%
Change in Gross State Product			
(millions of constant 1994 $)			
Total Over 10 yrs	$80m	$1.0	0.008%
Average year	$8m	$0.1	0.008%
Peak year	$14m	$0.2	0.016%
Net Present Value*	$60m	$0.8	0.008%

* Net Present Value is based on 5% discount rate, over and above 4.5% average inflation (All dollar amounts are already represented in constant 1994 $)

The results for each of the 8 scenarios are shown on the following pages. Since the impacts of energy efficiency programs are also sensitive to timing factors, including the lifetime of the installed measures and the number of years in which rate impacts are allocated, therefore these results are shown for every year from 1995 - 2015, rather than just at five year increments. All of these results are based on the following timing assumptions:

- The Rate impact is allocated over 4 years
  (so $80 million translates to a 1.25% rate increase over that period)
- The installed measures provide savings for ten years.
- The up-front rebate co-payment cost for the customer is incurred in the first year.

These jobs are not all created instantaneously, or even at the same time. The first scenario also reflects calculations that, as a result of the above timing assumptions, there is a net economic gain in the first year (due to purchase installation of energy saving measures), a loss in years 2-4 (due to additional cost of financing the measures) and major savings for years 5 - 10 (after financing is through, as energy savings are realized). The annual job estimates reflect a first-year gain due to the purchasing and installation of program measures, followed by a pattern of losses attributable to financing in the next few years and then made up by gains in the latter years.

If energy efficiency programs are continued at a high rate of $80 million/yr for ten years, as assumed for Scenario 2, then the total impact is over 19,000 job-years spread over twenty years. Scenario 3 shows that higher impacts result from focusing programs on the residential sector. This result is projected to occur because according to the REMI model data, residential customers in Iowa reinvest more of their energy savings on purchases of other Iowa products and services than do commercial and industrial customers. That result is also a reflection of the relatively low level rate of industrialization in Iowa. Comparison of Scenarios 4 - 6 show that targeting impacts on building Weatherization, HVAC and water heating measures provide more jobs and income than targeting programs on lighting technologies, due to the higher content of Iowa jobs associated with those technologies. Note, however, that this finding only holds for the state of Iowa. Impacts of other alternatives, representing low income residential programs and phase-out scenarios, are shown in Scenarios 7 and 8.

Overall findings are as follows:

- Iowa's current level of annual energy efficiency spending, totaling nearly $80 million, directly or indirectly supports nearly 500 current -year jobs in the stat, and the continuing energy savings will help support an average of over 200 annual jobs in future years.

- In general, spending on energy efficiency programs for one year can lead to the creation of 25 job-years per million dollars spent, and $1.50 of additional disposable income per dollar spent. These jobs and this income is, however, spread out over a decade.

- These impacts represent both the jobs created by spending on energy efficiency in Iowa (rather than allowing additional fuel cost to flow out of the Iowa economy), and the income created in subsequent years from respending of energy savings -- after adjusting for increases in energy costs to pay for these programs.

- The overall impact of any of these scenarios, while significant, causes less than 2/100 of 1% change in Iowa's employment and income.

Tables 18 a - h, shown on the following pages, provide details of the scenario results.

TABLE 18

ENERGY EFFICIENCY SCENARIO **1. Full DSM Mix -- $80m/yr for One Yr.**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRP	32	-10	-10	-10	12	13	12	13	13	14	0
Disposable Income	19	0	0	0	20	21	20	21	21	21	0
Total Employment	498	-60	-62	-68	272	286	280	287	294	301	0
Employment by Sector											
Agriculture	128	0	0	0	9	10	9	9	10	10	0
Mining	6	4	3	3	16	17	16	16	16	16	0
Construction	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	0
Durable goods	15	-28	-27	-27	-7	-5	-5	-4	-3	-3	0
Non-durable goods	-13	-43	-43	-42	-30	-28	-27	-26	-25	-24	0
Transport	18	1	1	0	20	21	20	21	21	21	0
FIRE	62	-5	-6	-7	67	70	69	70	72	73	0
Wholesale	13	-8	-8	-8	3	4	4	4	4	5	0
Retail	233	6	5	2	127	130	128	130	132	134	0
Services	0	0	0	0	2	2	2	2	2	2	0
State & Loc Gov't	38	15	14	13	67	68	66	67	68	68	0
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
GRP	0	0	0	0	0	0	0	0	0	0	80
Disposable Income	0	0	0	0	0	0	0	0	0	0	144
Total Employment	0	0	0	0	0	0	0	0	0	0	2029
Employment by Sector											
Agriculture	0	0	0	0	0	0	0	0	0	0	186
Mining	0	0	0	0	0	0	0	0	0	0	113
Construction	0	0	0	0	0	0	0	0	0	0	-19
Durable goods	0	0	0	0	0	0	0	0	0	0	-96
Non-durable goods	0	0	0	0	0	0	0	0	0	0	-303
Transport	0	0	0	0	0	0	0	0	0	0	146
FIRE	0	0	0	0	0	0	0	0	0	0	466
Wholesale	0	0	0	0	0	0	0	0	0	0	14
Retail	0	0	0	0	0	0	0	0	0	0	1026
Services	0	0	0	0	0	0	0	0	0	0	13
State & Loc Gov't	0	0	0	0	0	0	0	0	0	0	483
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	80	60
Real Disp Inc	144	109
Employment	2029	1561

Note: GRP and disposable income in 1994 million dollars; employment in persons

ENERGY EFFICIENCY SCENARIO **2. Full DSM Mix -- $80m/yr for 10 Yrs.**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRP	32	0	-9	-20	-8	9	21	37	26	64	67
Disposable Income	19	8	9	9	29	52	72	96	76	139	128
Total Employment	498	180	126	49	321	660	938	1275	1009	1793	1708
Employment by Sector											
Agriculture	128	18	19	19	28	39	47	58	48	63	58
Mining	6	9	13	16	32	49	66	84	67	116	103
Construction	-2	-4	-6	-8	-10	-12	-14	-15	-13	-17	-14
Durable goods	15	-38	-65	-92	-99	-98	-103	-104	-95	-93	-61
Non-durable goods	-13	-69	-112	-154	-184	-204	-231	-256	-223	-277	-216
Transport	18	7	9	9	29	53	73	97	77	143	131
FIRE	62	21	17	9	76	157	226	309	243	463	433
Wholesale	13	-7	-14	-22	-19	-13	-9	-3	-6	10	16
Retail	233	190	197	192	319	465	592	737	611	887	813
Services	0	1	1	1	3	5	7	9	7	13	12
State & Loc Gov't	38	52	68	79	146	219	285	360	293	484	433
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
GRP	97	108	93	78	60	40	21	0	0	0	713
Disposable Income	159	161	139	115	89	59	30	0	0	0	1391
Total Employment	2206	2300	1988	1647	1278	848	438	0	0	0	19264
Employment by Sector											
Agriculture	71	72	62	51	39	26	13	0	0	0	859
Mining	124	123	105	86	66	44	23	0	0	0	1131
Construction	-14	-12	-10	-8	-6	-4	-2	0	0	0	-173
Durable goods	-39	-14	-9	-6	-3	-3	-1	0	0	0	-907
Non-durable goods	-211	-175	-146	-118	-89	-60	-30	0	0	0	-2770
Transport	161	163	140	116	90	60	31	0	0	0	1406
FIRE	545	559	483	401	311	206	107	0	0	0	4628
Wholesale	31	38	34	28	22	15	8	0	0	0	122
Retail	1004	1016	875	723	559	372	192	0	0	0	9980
Services	14	14	12	10	8	5	3	0	0	0	128
State & Loc Gov't	519	515	442	364	281	187	96	0	0	0	4861
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	713	398
Real Disp Inc	1391	827
Employment	19264	11470

Note: GRP and disposable income in 1994 million dollars; employment in persons

ENERGY EFFICIENCY SCENARIO **3 -- Resid. Only DSM Mix -- $80m /yr for 10 Yrs**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRP	45	24	25	24	62	107	145	190	150	261	239
Disposable Income	28	24	32	37	79	125	166	213	171	297	266
Total Employment	692	513	591	630	1273	1998	2639	3376	2727	4529	4103
Employment by Sector											
Agriculture	131	27	31	34	55	78	98	121	99	146	130
Mining	11	19	27	34	66	100	132	167	134	228	202
Construction	-1	-3	-4	-6	-7	-8	-9	-10	-9	-11	-9
Durable goods	26	-12	-25	-40	-20	8	28	55	36	112	115
Non-durable goods	-2	-43	-71	-99	-107	-107	-113	-115	-106	-103	-70
Transport	26	21	29	35	76	122	162	209	168	294	264
FIRE	94	78	101	115	258	418	560	726	583	1022	924
Wholesale	20	6	4	1	17	37	53	73	57	107	100
Retail	326	326	375	405	660	942	1195	1479	1221	1831	1644
Services	1	2	3	3	7	10	14	18	14	25	22
State & Loc Gov't	61	91	122	147	268	398	518	653	530	878	781
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
GRP	297	302	258	212	163	109	56	0	0	0	2669
Disposable Income	322	320	275	226	174	116	60	0	0	0	2929
Total Employment	5012	5031	4320	3557	2744	1826	939	0	0	0	46499
Employment by Sector											
Agriculture	156	156	133	108	83	55	28	0	0	0	1670
Mining	241	238	202	165	127	84	43	0	0	0	2220
Construction	-9	-7	-6	-5	-4	-2	-1	0	0	0	-113
Durable goods	163	178	154	128	100	66	34	0	0	0	1107
Non-durable goods	-48	-22	-17	-12	-8	-6	-3	0	0	0	-1052
Transport	318	317	272	224	172	115	59	0	0	0	2884
FIRE	1121	1121	964	795	615	409	211	0	0	0	10114
Wholesale	128	132	114	94	73	48	25	0	0	0	1089
Retail	1982	1972	1693	1393	1074	716	368	0	0	0	19602
Services	27	26	23	19	14	10	5	0	0	0	242
State & Loc Gov't	932	920	788	648	499	333	171	0	0	0	8737
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	2669	1605
Real Disp Inc	2929	1766
Employment	46499	28242

Note: GRP and disposable income in 1994 million dollars; employment in persons

ENERGY EFFICIENCY SCENARIO **4 --Bldg. Shell & Const. only-- $80m/yr for 10 Yrs**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRP	17	14	11	7	24	47	64	86	69	118	112
Disposable Income	14	19	25	29	53	81	105	134	110	182	163
Total Employment	327	357	400	411	758	1181	1535	1959	1613	2568	2340
Employment by Sector											
Agriculture	22	24	27	28	40	52	63	75	64	81	72
Mining	9	15	22	27	46	66	84	105	86	139	122
Construction	-1	-3	-5	-7	-9	-10	-11	-13	-11	-14	-11
Durable goods	3	-16	-34	-54	-54	-45	-43	-37	-36	-23	-4
Non-durable goods	-9	-44	-78	-112	-135	-148	-168	-186	-162	-208	-160
Transport	13	19	25	30	54	82	106	135	111	183	164
FIRE	77	91	107	116	199	298	382	483	400	627	567
Wholesale	40	36	33	27	33	43	49	57	51	41	41
Retail	135	170	210	237	388	562	714	891	740	1143	1022
Services	1	1	2	3	5	7	9	12	10	16	14
State & Loc Gov't	38	64	91	115	191	274	349	437	360	582	513
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
GRP	142	147	127	105	81	54	28	0	0	0	1253
Disposable Income	194	192	165	136	105	70	36	0	0	0	1812
Total Employment	2852	2855	2463	2038	1579	1049	541	0	0	0	26826
Employment by Sector											
Agriculture	86	85	73	60	46	31	16	0	0	0	944
Mining	143	139	119	98	75	50	26	0	0	0	1371
Construction	-11	-10	-8	-7	-5	-3	-2	0	0	0	-141
Durable goods	20	37	34	30	24	15	8	0	0	0	-174
Non-durable goods	-153	-124	-103	-83	-62	-43	-21	0	0	0	-2001
Transport	195	192	165	136	106	70	36	0	0	0	1825
FIRE	682	677	584	483	375	249	129	0	0	0	6526
Wholesale	56	60	52	44	34	22	12	0	0	0	730
Retail	1217	1199	1032	852	659	438	226	0	0	0	11835
Services	17	16	14	12	9	6	3	0	0	0	158
State & Loc Gov't	601	584	502	413	319	212	109	0	0	0	5755
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	1253	746
Real Disp Inc	1812	1101
Employment	26826	16339

Note: GRP and disposable income in 1994 million dollars; employment in persons

ENERGY EFFICIENCY SCENARIO **5 -- Lighting, Elec. Equipment -- $80m/yr for 10 Yrs**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRP	19	-10	-23	-37	-32	-23	-17	-9	-13	8	19
Disposable Income	13	3	1	-1	13	30	45	62	48	96	90
Total Employment	345	56	-44	-162	9	243	423	648	488	1014	1033
Employment by Sector											
Agriculture	91	12	11	10	17	25	31	38	32	43	40
Mining	4	6	9	11	23	37	49	63	50	88	79
Construction	-2	-5	-7	-10	-12	-14	-16	-18	-15	-20	-16
Durable goods	-1	-51	-84	-116	-131	-138	-151	-161	-143	-159	-116
Non-durable goods	-27	-85	-133	-181	-219	-246	-280	-312	-271	-339	-268
Transport	12	2	1	-1	14	32	47	65	50	101	94
FIRE	39	-2	-14	-30	16	75	123	183	138	302	293
Wholesale	6	-13	-22	-32	-32	-29	-29	-28	-26	-19	-9
Retail	191	149	142	126	218	328	421	528	437	626	585
Services	0	0	1	1	2	4	5	7	5	10	9
State & Loc Gov't	31	42	52	60	113	170	223	283	229	380	341
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
GRP	42	55	48	41	32	21	11	0	0	0	133
Disposable Income	115	119	103	85	66	44	23	0	0	0	955
Total Employment	1427	1551	1347	1122	874	578	300	0	0	0	11252
Employment by Sector											
Agriculture	50	52	45	37	28	19	10	0	0	0	590
Mining	96	95	82	67	52	34	18	0	0	0	864
Construction	-16	-14	-12	-10	-7	-5	-2	0	0	0	-199
Durable goods	-101	-72	-59	-46	-34	-24	-12	0	0	0	-1599
Non-durable goods	-267	-226	-190	-153	-116	-79	-40	0	0	0	-3431
Transport	119	122	105	87	67	45	23	0	0	0	986
FIRE	383	403	349	290	226	150	78	0	0	0	3001
Wholesale	2	11	10	9	8	5	3	0	0	0	-184
Retail	739	759	655	542	420	279	144	0	0	0	7290
Services	11	11	10	8	6	4	2	0	0	0	97
State & Loc Gov't	412	410	352	290	224	149	77	0	0	0	3838
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	133	30
Real Disp Inc	955	556
Employment	11252	6433

Note: GRP and disposable income in 1994 million dollars; employment in persons

ENERGY EFFICIENCY SCENARIO **6 --HVAC and Hot Water: $80m/yr for 20 Yrs**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRP	36	5	-2	-9	7	28	44	64	48	98	96
Disposable Income	21	10	12	12	35	60	83	109	87	157	144
Total Employment	538	217	192	144	469	855	1183	1572	1249	2187	2043
Employment by Sector											
Agriculture	143	19	20	21	31	43	53	64	54	72	65
Mining	6	9	13	16	34	52	70	89	71	124	110
Construction	-1	-3	-5	-7	-8	-9	-11	-12	-11	-14	-11
Durable goods	23	-27	-47	-69	-69	-62	-60	-55	-54	-35	-13
Non-durable goods	-5	-54	-88	-121	-143	-156	-175	-191	-168	-203	-156
Transport	21	9	11	12	35	60	83	110	87	159	145
FIRE	68	26	27	24	102	192	269	363	286	536	495
Wholesale	13	-6	-11	-17	-11	-3	4	12	6	31	34
Retail	234	190	203	204	345	505	646	805	664	991	903
Services	0	1	1	1	3	6	8	10	8	14	13
State & Loc Gov't	37	52	67	79	150	227	297	377	306	511	458
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
GRP	129	138	119	98	76	50	26	0	0	0	1053
Disposable Income	177	179	154	127	98	65	34	0	0	0	1565
Total Employment	2586	2661	2294	1897	1469	976	503	0	0	0	23037
Employment by Sector											
Agriculture	80	81	69	57	43	29	15	0	0	0	958
Mining	133	132	113	92	71	47	24	0	0	0	1205
Construction	-11	-9	-8	-6	-5	-3	-2	0	0	0	-136
Durable goods	13	33	31	27	22	14	8	0	0	0	-319
Non-durable goods	-147	-117	-98	-78	-59	-40	-20	0	0	0	-2020
Transport	178	179	154	127	98	65	34	0	0	0	1567
FIRE	617	628	542	448	347	231	119	0	0	0	5321
Wholesale	50	56	48	40	32	21	11	0	0	0	309
Retail	1109	1118	962	794	614	408	210	0	0	0	10904
Services	15	15	13	11	8	6	3	0	0	0	137
State & Loc Gov't	550	546	469	386	298	198	102	0	0	0	5110
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	1053	613
Real Disp Inc	1565	934
Employment	23037	13815

Note: GRP and disposable income in 1994 million dollars; employment in persons

ENERGY EFFICIENCY SCENARIO **7 -- Low Income Resid.-- $80m over 4 Yrs**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRP	10	6	6	6	11	21	31	41	42	42	36
Disposable Income	7	6	8	10	16	26	34	44	44	45	38
Total Employment	155	122	145	158	222	378	520	686	695	702	596
Employment by Sector											
Agriculture	29	7	8	9	9	13	17	22	22	22	18
Mining	3	5	7	9	14	21	27	34	34	34	28
Construction	0	-1	-1	-2	-2	-1	-1	-1	-1	-1	-1
Durable goods	6	-3	-6	-10	-5	5	13	23	24	24	21
Non-durable goods	-1	-11	-18	-25	-23	-17	-11	-5	-5	-4	-3
Transport	6	6	8	10	16	25	34	43	44	44	38
FIRE	24	22	28	32	53	86	116	152	154	156	133
Wholesale	6	3	3	2	3	8	12	18	18	18	16
Retail	68	71	84	94	102	158	210	271	273	276	234
Services	0	0	1	1	2	2	3	4	4	4	3
State & Loc Gov't	14	22	30	37	54	78	101	127	128	129	109
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
GRP	23	13	0	0	0	0	0	0	0	0	287
Disposable Income	25	14	0	0	0	0	0	0	0	0	316
Total Employment	389	214	0	0	0	0	0	0	0	0	4983
Employment by Sector											
Agriculture	12	7	0	0	0	0	0	0	0	0	195
Mining	18	10	0	0	0	0	0	0	0	0	243
Construction	-1	0	0	0	0	0	0	0	0	0	-13
Durable goods	14	8	0	0	0	0	0	0	0	0	113
Non-durable goods	-2	-1	0	0	0	0	0	0	0	0	-125
Transport	24	13	0	0	0	0	0	0	0	0	312
FIRE	87	48	0	0	0	0	0	0	0	0	1091
Wholesale	10	6	0	0	0	0	0	0	0	0	124
Retail	152	84	0	0	0	0	0	0	0	0	2076
Services	2	1	0	0	0	0	0	0	0	0	26
State & Loc Gov't	71	39	0	0	0	0	0	0	0	0	941
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	Sum of All Years	Net Present Value
Gross Reg Prod	287	198
Real Disp Inc	316	219
Employment	4983	3470

Note: GRP and disposable income in 1994 million dollars; employment in persons

ENERGY EFFICIENCY SCENARIO **8. Phase Down Full DSM: $80m to 0 in 4 Yrs.**

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
GRP	32	-2	-12	-20	-3	16	26	33	35	36	24
Disposable Income	19	6	5	2	20	37	46	53	54	54	36
Total Employment	498	120	18	-84	176	462	625	735	754	771	519
Employment by Sector											
Agriculture	128	14	10	5	10	17	21	24	24	25	16
Mining	6	8	9	9	21	32	38	42	42	42	28
Construction	-2	-3	-5	-6	-5	-5	-5	-5	-4	-4	-3
Durable goods	15	-35	-53	-64	-48	-29	-18	-11	-9	-7	-3
Non-durable goods	-13	-63	-88	-102	-94	-80	-73	-67	-65	-62	-39
Transport	18	6	5	3	21	38	47	53	54	55	37
FIRE	62	14	4	-7	58	120	156	180	184	188	126
Wholesale	13	-7	-13	-17	-8	2	7	11	11	12	9
Retail	233	144	103	54	132	234	293	332	338	343	229
Services	0	1	1	1	2	4	4	5	5	5	3
State & Loc Gov't	38	43	45	40	87	130	155	171	173	175	116
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
GRP	12	4	0	0	0	0	0	0	0	0	180
Disposable Income	18	7	0	0	0	0	0	0	0	0	358
Total Employment	253	96	0	0	0	0	0	0	0	0	4943
Employment by Sector											
Agriculture	8	3	0	0	0	0	0	0	0	0	305
Mining	14	5	0	0	0	0	0	0	0	0	293
Construction	-1	-1	0	0	0	0	0	0	0	0	-48
Durable goods	-2	-1	0	0	0	0	0	0	0	0	-265
Non-durable goods	-19	-7	0	0	0	0	0	0	0	0	-773
Transport	18	7	0	0	0	0	0	0	0	0	363
FIRE	62	23	0	0	0	0	0	0	0	0	1171
Wholesale	4	2	0	0	0	0	0	0	0	0	25
Retail	112	42	0	0	0	0	0	0	0	0	2589
Services	2	1	0	0	0	0	0	0	0	0	33
State & Loc Gov't	57	21	0	0	0	0	0	0	0	0	1250
Federal Gov't	0	0	0	0	0	0	0	0	0	0	0
Farm Emp	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	180	123
Real Disp Inc	358	253
Employment	4943	3523

Note: GRP and disposable income in 1994 million dollars; employment in persons

Comparison to Prior Study

Prior to this study, the State of Iowa utilized an energy job impact spreadsheet template which was developed in 1987. The results shown here provide generally smaller impacts than those forecasted by the 1987 spreadsheet. The reasons for this difference are as follows:

Coverage of Key Issues. The old spreadsheet had the following limitations which are addressed in the new analysis models.

- **time dimension -** The old spreadsheet assumed that energy savings are the same every year, even though we know that many types of installed DSM measures have significant loss of savings over time, while some types of programs can also accumulate savings over time. Most seriously, the old template assumed that program costs are amortized over the lifetime of the energy savings (and without any explicit financing costs). In fact, utilities now typically recover costs with interest over a 1-4 year period.

- **program mix -** The old spreadsheet assumed that there is a fixed spending multiplier for all program investments. It was not sensitive to differences in type of DSM programs (e.g., direct installation of insulation and weatherization measures vs. appliance rebate programs), even though we know that they have very different levels of labor requirements and cause very different types of product demand for Iowa industries.

- **program targets -** The old spreadsheet assumed that there was a fixed energy savings multiplier effect on jobs. It was not sensitive to differences in the sectoral mix of program beneficiaries (i.e., residential, commercial, industrial, agricultural), even though we know that they have very different responses to cost factor changes.

Assumptions. The old spreadsheet and new analysis model differ in some major assumptions.

- **energy costs -** Impacts were estimated from the old template by effectively assuming that energy costs will escalate at a rate of 3% per year <u>over and above the normal rate of inflation occurring for other goods and services.</u> This served to increase the economic value of energy savings over that assumed in our new estimates, which is that energy prices in real (inflation adjusted) terms will remain stable).

- **program and cost recovery -** Impacts were estimated from the old template by effectively assuming that program costs can be amortized over a ten-year period. This served to decrease the project life cycle cost, since further-out years are heavily discounted. Our new estimate reflects the current real situation, which is that the Iowa utilities recover their DSM cost, with interest over 4 years.

- **labor intensity and prices responses -** Impacts estimated from the old template were built on an assumption of a very high difference in labor intensity between DSM activities and electric power provider activities. This served to increase job impacts (although not income impacts) compared to our new estimates, which incorporate REMI model forecasts of program impacts on labor costs and prices of product inputs as a result of additional demand for them.

3.6 Conclusions: Implications of Results

In the examples illustrated here, spending on energy efficiency programs is shown to create roughly 25 job-years of employment per million dollars invested, although in any one year this represents just 2.5 - 4.0 jobs per million dollars spent. Of course, these findings are calculated on the basis of program spending patterns, costs and benefits claimed by Iowa's utilities for their 1994 programs. Given that those programs and prior year programs have already served a portion of the residential and business sectors in accomplishing their work, it is not clear whether or not continuing the same types of programs at the same spending levels would necessarily continue to provide the same energy saving benefits. However, that is assumed for the calculation of economic impacts associated with continued, ten year spending.

SECTION 4: RENEWABLE ENERGY PRODUCTION

4.1 Approach

In this section, we present estimates of the economic impact of adoption of renewable energy in the electric utility sector. Specifically, we look at the potential effects of replacing a portion the existing purchases of coal-generated electricity with purchases of electricity from switchgrass or wind-powered generating facilities.

It is assumed that switchgrass would be co-fired in an existing coal-fired power plant, which means no additional capital cost is involved (although there is a higher operating cost involved). It is assumed that the substitution of wind power for coal power will, however, require new generating facilities. Impacts of adopting these energy options are analyzed relative to a “do nothing” status quo, in which Iowa continues to rely on available generating capacity which primarily utilizes coal from out-of-state. These assumptions are appropriate for analysis at this point in time, insofar as there is currently excess reserve generating capacity available to serve Iowa’s electricity needs.

Because of the range of choices that can be made about adoption of renewable energy -- e.g., amount of capacity replacement, year of facility construction -- and the importance of factors that cannot be predicted with great certainty -- e.g., which regions in Iowa will supply switchgrass, yield per acre, land costs -- it is impossible to predict the effects of a specific renewable energy program. What we attempt to do in this section, however, is to set reasonable bounds on the likely impacts of renewable energy programs in Iowa. To do this, we run a number of scenarios that use both different modeling assumptions and different modeling techniques. For example, we use different assumptions about land prices and switchgrass yield per acre in the biomass modeling; we also experiment with different techniques in wind energy modeling by testing the likely effects if consumers absorb all the costs (i.e., the utility passes on all costs to consumers or construction of facilities is funded with a tax increase) versus if the costs are treated as simply an increase in costs to public utilities.

The scenarios are not to be read as predictions. For example, when we model an increase in costs by decreasing purchasing power we are not suggesting that renewable energy programs will be directly funded by consumers which, in fact, seems unlikely. Rather we are trying to set a bound on the maximum effect of renewables energy programs on consumers. Similarly, when we model spending on renewables by increasing costs to electric utilities, we are not predicting that program costs will be treated in the same way as an increase in the price of coal or the construction of new transmission lines. However, by modeling it as a routine cost, we are able to bound the likely effects on the average electricity consumer.

We also experiment by changing the year in which construction costs are absorbed. In some of the scenarios, we model all construction costs as expenses incurred in the year the facility is built. This has the advantage of capturing the shock effects of construction projects, but does not address the likelihood that construction costs will be spread over a long period of time either through changes in electricity prices or a change in investment. Recognizing the shortcomings of this approach, we also run scenarios in which construction costs are finance overtime through charges on each kW hour of wind-generated electricity consumed--that is, we assume that construction costs will be financed through price increases for the lifetime of the equipment. This has the advantage of more realistically capturing the price mechanism. The shortcoming of the approach, though, is that can't capture the fact that the effects of expenditures are realized during facility construction. However, by using both of the approaches, we can capture the range of potential effects of the construction of wind facilities on the Iowa economy. In the following sections, first biomass power technologies and then wind energy technologies are discussed.

4.2 Overview of Existing Biomass Technologies

Biomass resources in Iowa include corn, metropolitan solid waste, wood wastes, residues from annual crops, manure from livestock in feedlots, and biomass from natural forests. The following is a summary of Biomass potentials. Iowa, according to the Iowa State University report “The potential for Biomass Production and Conversion in Iowa”. (Robert Brown, et al., 1994)

Corn. The grain availability for ethanol production does not appear to be limiting for these production-capacity goals. A level of 0.38 quads per year or 3.8 billion gallons per year would require that 12 to 15 million acres of corn be planted annually. That is roughly the current level of corn planting in Iowa.

Metropolitan Solid Waste (MSW). Increasing costs (tipping fees, transportation costs, etc.) for the disposal of waste materials, limits on available sanitary landfills, and changes in state and federal laws affecting the options for disposal of residential, commercial, industrial, and agricultural wastes are factors influencing the potential of energy recovery from the various organic waste streams in Iowa.

For Iowa, the estimated energy MSW generation rate is 560 pounds of MSW (and hence potential energy feedstock) each year. Given the 1992 population for Iowa is 2,802,944 (Risser, 1995), there is the potential of producing 784,824 tons per year of energy from MSW (Iowa State University).

Wood Wastes. The cost and environmental limits of disposal of wood wastes have caused the Iowa wood industry to find alternative ways to dispose of the material. In 1988 the Iowa primary wood industry produced 8.7 million cubic feet of coarse, fine, and bark residues. If market prices for the wood residue as a biofuel were to exceed those paid for the residue used as livestock bedding, composting, or landscape chips, then conceivably all 8.7 million cubic feet would be available.

Residues from Annual Crops. In Iowa (and nationwide), farmers who choose to be involved with the farm program and receive price-support payments (for Iowa the commodity support is for corn) must have approved conservation plans (for soil and water resources). One of the guidelines used in these conservation plans is a minimum requirement of retaining one ton of crop residue on the field to aid in reducing water- and air-borne soil erosion and improving or maintaining the soil tilth and long-term productivity. Iowa has about 12 million acres classified by the Soil Conservation Service (SCS) as highly erodible lands (HEL). When the Iowa Soil Conservation Service criteria for removal of 1 ton per acre from corn lands with 0-3% slopes is applied to all the counties in Iowa, it is estimated that over 11.5 million tons of corn residue is potentially available each year.

Manure from Livestock in Feedlots. The use of animal manure for biofuels (biogas or biosolids) is another possible option for the Iowa farmer. Manure from livestock in feedlots could produce an estimated 2.9 million tons of biomass each year primarily from cattle and swine. Manure from cattle and swine can be used to produce methane in technically advanced systems.

Biomass Resources from Iowa's Natural Forests. Beyond the potential use of wood residues from the Iowa wood industry, the forests of the state can contribute biomass from (1) logging residues, (2) forest improvement activities, and (3) capture of natural mortality. Without increasing the annual removal volume of growing stock and by increasing the use of the annual removals, it is theoretically possible for the natural forests of the state to produce 116 thousand tons of biomass. Also by recovering logging residues associated with the annual removals, an additional 24 thousand tons could be produced each year. Other factors such as preservation of wildlife and recreational areas, may also affect the availability of land for logging on Iowa's 2 million acres of forest land.

Iowa's transportation infrastructure is equipped to support various biomass-to-energy systems. The state's road, rail and waterway systems already support a strong and viable agricultural economy based on the movement of bulk commodities. The geographically limited areas in which a biomass-to-energy system would operate makes Iowa's road system, which already accesses all of Iowa's farms, the most feasible modes of transportation to support a biomass-to-energy system.

According to the Brown et al. report (1994), switchgrass is the lowest cost of any of the perennial grasses, and Brown seems to favor it throughout the report. That report presented a very thorough study of the yields, production costs, environmental impacts, etc. of different biomass possibilities. It surveyed results of the tests of four perennial grasses (alfalfa, reed canary grass, switchgrass, and big bluestem), five annual crops (sweet sorghum, sorghum and sudan grass hybrid, rye, corn, and soybean) and variations of intercropping some of them. It also examined feasibility and potential for municipal solid waste and short rotation woody crops in Iowa. It concluded that the production cost for switchgrass is generally one-half to one-sixth that of any of the other three grasses.

Environmental Concerns. It should be noted that the use of corn is not recommended for burning in power plants for several reasons: (1) it is better used to produce ethanol, and (2) it is also needed to be either left in the field or to be plowed back into the soil. Corn, sorghum, and other annual herbaceous species have the following negative environmental effects: soil erosion, nitrate run-off, and high pesticide applications (p. 401). Switchgrass and hybrid poplar reduce these problems "if employed in buffer strips along riparian zones". Also, biomass generally has low concentrations of heavy metals and low ash content (2-3 percent), while coal emits large amounts of toxic heavy metals, including mercury and cadmium, and ash of up to 20 percent or more by weight. In addition, biomass that has to be stored creates a potential health hazard for the handlers who are exposed to the spores and microorganisms that form. (All quotes from Brown et al., 1994)

Transportation of biomass creates additional energy costs and environmental concerns. Most biomass, like switchgrass, will have to be transported by truck. Diesel engines in trucks create significant air pollution of CO_2, CO, hydrocarbons, nitrogen oxides, particles, and sulfur dioxide. A switch to ethanol fuel from diesel fuel could cut the CO_2 emissions of the transportation industry in half. As of 1990, the estimated energy cost for hauling switchgrass to a biomass processing plant was 2.79 gigaJoules per hectare, and the environmental cost was estimated to be 449.6 pounds of CO_2 per hectare. Note that biomass power plants of 50 mW electrical generating capacity are considered to be the optimal given the constraints of economics of scale and limits on transporting biomass. (Source: Brown et al., 1994)

Net Impacts of biomass power generation involve both economic and environmental issues. Economically, the issues is the generation of jobs through substitution of a locally-supplied product in place of one supplied from out-of-state. There are, however, additional potential costs associated with storage and transportation of the bulkier biomass fuel and handling of alkali slagging from its combustion. Environmentally, the substitution of biomass for coal has potentially negative impacts associated with fertilizer and pesticide use as well as truck emissions, but these are offset by reduced emissions of heavy metals. The valuation of these "environmental externalities" is not included in the economic analyses for this study.

4.3 Construction of Scenarios for Biomass-Generated Electricity

There are many different biomass electric generation technologies. Based on a literature review and expert consultation, the decision was made to focus on modeling economic impacts of co-firing switchgrass in a coal-fired power plant, which looks quite promising for Iowa in the near future. This methodology and these results can also be used to assess economic impacts of other biomass electric generation technologies.

Modeling Approach

The economic impacts of co-firing switchgrass in coal fired power plant, and the modeling of these impacts, occurs through four main channels:

1. Increased Demand for Switchgrass, to be burned by electric utilities

2. Reduced Demand for Coal. A portion of coal will be replaced by switchgrass. This reduced Iowas' dependence on imported coal.

3. Electricity-Cost Increases. Because electricity from switchgrass is more costly than that from coal, electricity prices will have to be increased to finance generation cost increases. Electricity-cost variables and consumer-price are used to estimate macroeconomic impacts of electricity cost increases.

4. Increased Production of Switchgrass. The estimated input/cost structure of switchgrass production, transportation, and processing reflects a change in final demand patterns.

We assume that there is no significant construction cost associated with co-firing and that all the cost of co-firing switchgrass will be financed through electricity price increases. These assumptions can be modified and should be if, for example, there are major facility construction and modification and if the federal government provides funding for switchgrass electricity.

Steps in Data Preparation and Development of Scenarios

The scenario and data inputs for REMI modeling are prepared in seven steps.

1. Obtain information on current total electric generation capacity (Kw) and electricity production (Kwh) in Iowa.

2. Obtain information on the percentage/amount of electricity generated from coal and its fuel requirement.

3. Assume a given percentage of coal (Btu) will be replaced by switchgrass using co-firing technology. We then develop several scenarios for a range of replacement percentages for the period between 1995 and 2015.

4. Calculate the amount of dry switchgrass required by comparing energy content (Btu) of dry switchgrass with that of average coal used in Iowas electric utilities.

5. Convert tons of dry switchgrass into switchgrass production and acreage.

6. Estimate cost and input structure of switchgrass producing, transportation, and processing.

7. Estimate the impact of replacing coal with switchgrass on electricity prices based on cost $ / Btu difference between switchgrass and coal and the replacement percentage.

Construction of the resulting scenarios is summarized in Table 19 and the text which follows.

Table 19: Construction of Scenarios for Biomass Electricity

	Percentage of Coal Replaced by Switchgrass			
	1%	3%	5%	10%
Electricity from switchgrass:				
gWh/yr	275	825	1,376	2,751
gBtu/yr	938.3	2814.9	4694.9	9,386.4
Switchgrass required: (dry ton/yr):	55,194	165,582	276,171	55,2141
Acreage required/yr:				
high (normal, yield)	22,437	67,310	112,264	234,448
low (max yield with nitrogen)	11,218	33,655	56,132	112,224

Scenario	Replacement of Coal (% of electricity)	Switchgrass Yield (tons/acre)	Switchgrass Production Cost ($/acre)
1	Low (1%)	Low (2.5)	Low (226)
2	Low (1%)	Low (2.5)	High (261)
3	Low (1%)	High(4.9)	Low (226)
4	Low (1%)	High(4.9)	High (261)
5	High (10%)	Low (2.5)	Low (226)
6	Slow Growth (1-5%)	Low (2.5)	Low (226)
7	High Growth (1-10%)	Low (2.5)	Low (226)
8	Slow Growth (1-5%)	High(4.9)	High (261)

Supporting Data for Table 19

1. **Total electricity generation in Iowa (1993)**
   32.104 billion kWh: $1.916 Billion
   (Source: Electric Power Annual, 1994)

2. **Generating Capability at Electric Utilities of Iowa (1993):**
   8074 mW Summer, 8427 mW winter
   (Source: Inventory of Power Plants, 1994)

3. **Electricity generation from coal in Iowa (1993):**
   26,643 gWh; 85.7% of total
   (Source: Electric Power Annual, 1994)

4. **Heating value of switchgrass**
   7,741 Btu/lb (dry matter) = 17 million/dry ton
   (Source: Brown et al., 1994)

5. **Comparison of energy densities of biomass and coal:**

	biomass	coal
Calorific value (GJ/dry ton)	16-24	29-37
Energy Density of net material (GJ/m^3)	< 1-15	43

(Source: Boyles, 1984)

6. **Switchgrass Yield (dry-matter):**
2.46 - 4.73 ton/acre (depending on nitrogen use) in Ames
3.14 - 4.92 ton/acre (depending on nitrogen use) in Chariton
Source: (Brown, 1994)

7. **First year production costs for switchgrass production** (per acre):

(Unit: $)	High Cost (Ames)	Low Cost (Chariton)
seed	24.50	25.20
fertilizer (excl Nitrogen)	23.98	23.98
Herbicide	3.95	3.95
machinery fuel	4.99	4.99
R & M	18.01	18.01
fixed cost	43.35	43.34
labor	9.38	9.38
interest	4.76	4.78
transportation	13.78	13.03
land	115.00	80.00
total establishment	$261.70	$226.68

Source: Brown et al., 1994

8. **Estimated biomass acreage required for electricity generation:**

heat rate of power plant (50-MW)	Acreage required
12,500 Btu/kWh	65,000
10,200 Btu/kWh	53,000

Source: Brown et al., 1994

9. **Prevailing biomass price in the U.S.:** $42.00 dry ton.
Source: Brown et al., 1994

Description of Scenarios

Biomass Scenario 1: **Low replacement of coal; low switchgrass yield per acre; low production costs**

1) Penetration of biomass energy: 1.0% of coal-generated electricity, 1995-2015

2) Annual utility cost increase for electricity production of $3.77 million. (Computed as 321 million kWh @ 1.17¢/kWh estimated additional cost) .

3) Increased demand for switchgrass assumed to be met by Iowa producers; annual agricultural products sales increase of $8.97 million dollars.

Biomass Scenario 2: **Low replacement of coal; low switchgrass yield per acre, high production costs**

1) Penetration of biomass energy: 1% of coal-generated electricity, 1995-2015

2) Annual utility cost increase for electricity production of $8.01 million.

3) Increased demand for switchgrass assumed to be met by Iowa producers; annual agricultural products sales increase of $13.21 million.

Biomass Scenario 3: **Low replacement of coal; high switchgrass yield per acre, low production costs** (assumes use of added nitrogen)

1) Penetration of biomass energy: 1.0% of coal-generated electricity, 1995-2015

2) Annual utility cost increase of $1.5 million for electricity production

3) Increased demand for switchgrass assumed to be met by Iowa producers. Annual agricultural sales increase of $6.70 million dollars.

Biomass Scenario: 4 Low replacement of coal; high switchgrass yield per acre, high production costs (assumes use of nitrogen)

1) Penetration of biomass energy: 1.0% of coal-generated electricity, 1995-2015

2) Annual utility cost increase of $4.04 million for electricity production

3) Increased demand for switchgrass assumed to be met by Iowa producers. Annual agricultural sales increase of $7.24 million.

Biomass Scenario 5: High replacement of coal, low switchgrass yield per acre; low production costs

1) Penetration of biomass energy: 10% of coal-generated electricity, 1995-2015.

2) Annual utility cost increase for electricity production of $37.7 million.

3) Increased demand for switchgrass to be met by annual agricultural sales increase of $89.7 million.

Biomass Scenario 6: Slow growth replacement of coal; low switchgrass yield per acre; low production costs

1) Penetration of biomass energy: 1% of coal-generated electricity in 1995; 2% in 2000; 3% in 2005; 4% in 2010; 5% in 2015.

2) Annual utility cost increases for electricity production of $3.77 million (1995-1999); $7.54 (2000-2004); $11.31 million (2005-2009); $15.08 million (2010-2014) and $18.85 million (2015).

3) Increased demand for switchgrass assumed to be met by Iowa agricultural sales increase of $7.86 (1995-1999); 15.72 million (2000-2004); $23.58 million (2005-2009); $31.44 million (2010-2014) and $39.30 million (2015) Increased fertilizer demands of $1.10 million (1995-1999); $2.21 million (2000-2004); $3.31 million (2005-2009); $4.40 million (2010-2014) and $5.52 million (2015).

Biomass Scenario 7: High growth replacement of coal; low switchgrass yield per acre; low production costs

1) Penetration of biomass energy: 1% of coal-generated electricity in 1995; 4% in 2000; 6% in 2005; 8% in 2010; 10% in 2015.

2) Utility generating cost increases of $3.77 million (1995-1999); $15.08 million (2000-2004); $22.62 million (2005-2009); $30.16 million (2010-2014), 37.70 million (2015).

3) Increased demand for switchgrass assumed to be met by Iowa producers. Increased agricultural sales of $28.61 million(1995-1999); $31.44 million (2000-2004); $47.16 million (2005-2009); $62.89 million (2010-2014) and $78.61 million (2015). Increased fertilizer demands of $1.10 million (1995-1999); $4.42 million (2000-2004); $6.63 million (2005-2009); $8.84 million (2010-2014) and $11.05 million (2015).

Biomass Scenario 8: Slow growth replacement of coal; high switchgrass yield per acre; high production costs (assumes use of added nitrogen).

1) Penetration of biomass energy: 1% of coal-generated electricity in 1995; 2% in 2000; 3% in 2005; 4% in 2010; 5% in 2015.

2) Utility generating production cost increases of \$3.77 million (1995-1999); \$7.54 million (2000-2004); \$11.31 million (2005-2009); \$15.08 million (2010-2014) and \$18.85 million (2015).

3) Increased demand for switchgrass assumed to be met by Iowa agricultural sales increases of \$6.09 million (1995-1999); \$12.18 million (2000-2004); \$18.27 million (2005-2009); \$24.36 million (2010-2014) and \$30.45 million (2015) Increased fertilizer demands of \$1.13 million (1995-1999); \$2.27 million (2000-2004); \$3.40 million (2005-2009); \$4.53 million (2010-2014) and \$5.66 million (2015).

4.4 Biomass Scenario Results

Results for an aggressive scenario in which 1% of Iowa's electricity is generated from switchgrass -- represented by scenario 6 -- are shown in Table 20. These model results are based on an assumption that there is no up front capital spending, but only the added cost of purchasing and burning switchgrass in place of coal in existing power plants. The results indicate that the higher cost to Iowa business (causing a loss of jobs) is more than offset by the "import substitution" effect, which is the flow of money to create Iowa jobs supplying switchgrass in place of money previously flowing out of the state to purchase coal. (The corresponding loss of jobs in the coal industry is out-of-state and hence ignored here.)

Table 20: Economic Impact of Generating 1% of Electricity from Switchgrass

	Absolute Amount	Ratio: Per Million Dollars Spent	Percent Increase Over State Total
Change in Spending			
Total Over 10 yrs	$37.7 m	n.a.	n.a.
Average Year	$3.77 m	n.a.	n.a.
Peak Year	$3.77 m	n.a.	n.a.
Change in Jobs			
Total Over 10 yrs (Job-yrs)	3,150	84	0.02%
Average Year	315	84	0.02%
Peak Year	373	99	0.02%
Change in Disposable Income			
(millions of constant 1994 dollars)			
Total Over 10 yrs	$55m	1.4	0.02%
Average Year	$6m	1.4	0.02%
Peak Year	$7m	1.8	0.03%
Change in Gross State Product			
(millions of constant 1994 dollars)			
Total Over 10 yrs	$75m	2.1	0.01%
Average year	$8m	2.1	0.01%
Peak year	$ 9m	2.9	0.02%

The overall effect (as shown in the above table) is 315 jobs/year in Iowa, and an increase in personal income of $5.5 million. This represents 84 jobs per million dollars spent on biomass energy, and $1.46 of income to Iowa residents for every $1.00 spent on biomass energy.

Of course, all of the economic impacts shown here for switchgrass are contingent on assumed operating costs, use of existing combustion facilities with no additional capital costs, and an effective solution to overcome the “alkali slagging” problem now holding back switchgrass burning power plants. The estimate of job impacts for biomass is also believed to be an upside estimate, since the economic model lacks applicable data on the ultimate labor-intensiveness of large scale switchgrass production and harvesting in the state.

Estimates of economic impacts for all eight biomass scenarios are presented in Table 21 (a - h), on the pages which follow. Since the biomass scenarios have no concentration of capital spending or needs for short-term financing for capital costs (as was the case for energy efficiency programs), there are no dramatic differences between short-term and long-term results. Rather, the model predicts generally stable employment and income results with a trend of the job impacts slowly falling over time as labor markets and labor prices adjust to provide a new labor market equilibrium of supply and demand.

Overall, these scenarios show that estimates of the annual employment effects of biomass energy programs range from around 230 jobs/year (Scenario 3) to over 3000 jobs/year (Scenario 5). Over 2/3 of these jobs are in the farm and agriculture services sector. There is significant uncertainty concerning the labor requirements for a future large-scale switchgrass industry; so the current job estimates may be considered to be upside estimates. There is almost no effect on Gross State (Regional) Product in Scenario 3 but an increase of around $67 million in Gross State Product in Scenario 5. This range of results is not surprising as we use very different assumptions in each of the scenarios. In Scenario 3, we assume that switchgrass replaces 1% of coal. (To operationalize this assumption, we use heat content data for coal and switchgrass and assume the same conversion efficiency.) We also assume a high yield of switchgrass per acre and low production costs. In this scenario, we separate fertilizer purchases from the value of sales of switchgrass; this lowers estimates of economic impacts because Iowa has a very small chemical products sector so almost all of the spending on fertilizer leaves the state.

The assumptions in Scenario 5 are rather different. We assume very high substitution of switchgrass for coal by replacing 10% of current consumption of coal in electricity generation with switchgrass. We also assume low switchgrass yield per acre and low production costs. We do not separately model the costs of fertilizer but aggregate all spending on switchgrass in agricultural sales.

To provide perspective on the size of the estimated economic impacts, refer to the REMI control forecast for Iowa, shown earlier in Table 1 (end of Section 2). As the data show, Gross State Product for Iowa is over $82 billion dollars and employment in the state is almost 1,800,000. Thus, the low estimates suggest that replacement of coal with switchgrass for electricity generation will have essentially no effect on the state economy. The highest estimate suggests that use of switchgrass will increase GSP by around 0.1% and employment by 0.2%.

TABLE 21.
ECONOMIC IMPACT OF ALTERNATIVE SCENARIOS FOR ELECTRICITY FROM BIOMASS
(Gross State Product and disposable income in 1994 million dollars; employment in persons)

IOWA STATE IMPACT OF ENERGY POLICIES
SCENARIO: Biomass Scenario 1: Low Level, Low Switchgrass Yield, Low Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Results (1995 $)										
Gross Reg Prod	$9	$9	$8	$8	$8	$7	$7	$7	$7	$7
Real Disp Inc	$7	$7	$7	$6	$6	$6	$6	$5	$5	$5
Employment	373	358	338	330	322	305	303	298	292	286
Employment by Sector										
Agriculture/Farm	264	255	244	239	234	226	225	224	223	221
Mining	0	0	0	0	0	0	0	0	0	0
Construction	17	16	15	15	14	13	13	12	12	11
Durable Goods	1	1	1	0	0	0	0	0	0	0
Non-Dur Goods	2	2	2	1	1	1	1	1	1	1
Tran & Util	5	5	5	5	5	4	4	4	4	4
Finan, Ins & RE	7	6	6	6	5	5	5	5	4	4
Wholesale	7	6	6	6	6	5	5	5	5	5
Retail	26	25	22	21	21	18	18	16	15	14
Services	40	38	35	34	33	29	29	27	25	24
State & Loc Govt	4	4	3	3	3	3	3	3	2	2
Federal Govt	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Results (1995 $)										
Gross Reg Prod	7	7	7	7	7	7	7	6	7	7
Real Disp Inc	5	5	5	5	5	5	5	4	4	4
Employment	282	284	284	282	280	281	282	279	280	281
Employment by Sector										
Agriculture/Farm	221	222	224	225	226	226	226	226	227	227
Mining	0	0	0	0	0	0	0	0	0	0
Construction	11	11	10	10	10	10	10	10	10	10
Durable Goods	0	0	0	0	0	0	0	0	0	0
Non-Dur Goods	1	1	1	1	1	1	1	1	1	1
Tran & Util	4	4	4	4	4	4	4	4	4	4
Finan, Ins & RE	4	4	4	3	3	3	3	3	3	3
Wholesale	5	5	5	5	4	4	5	4	4	4
Retail	13	13	12	12	11	11	11	10	10	10
Services	22	22	22	21	20	20	20	19	19	19
State & Loc Govt	2	2	2	2	2	2	2	2	2	2
Federal Govt	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	149.5	96.7
Real Disp Inc	110.9	73.1
Employment	6299	4057

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Biomass Scenario 2: Low Level, Low Switchgrass Yield, High Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	$13	$12	$12	$11	$11	$10	$10	$10	$10	$9	$9
Real Disp Inc	$10	$10	$9	$9	$8	$7	$7	$7	$6	$6	$6
Employment	534	512	479	467	455	426	424	414	403	392	379
Employment by Sector											
Agriculture/Farm	389	375	360	352	344	333	331	330	328	326	323
Mining	1	1	1	1	1	1	1	1	1	1	1
Construction	23	22	20	19	19	16	16	15	14	13	11
Durable Goods	1	1	1	1	1	0	0	0	0	0	0
Non-Dur Goods	2	2	2	2	2	1	1	1	1	1	1
Tran & Util	8	8	8	8	7	7	7	6	6	6	6
Finan, Ins & RE	9	8	7	7	7	5	5	5	4	4	3
Wholesale	9	9	8	8	8	7	7	7	7	6	6
Retail	35	33	28	27	26	20	20	17	15	12	9
Services	51	48	42	40	39	32	32	28	25	21	18
State & Loc Govt	5	5	4	4	4	3	3	3	2	2	2
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	9	9	9	9	9	9	9	9	9	9	206
Real Disp Inc	6	6	5	5	5	5	5	5	5	5	136
Employment	383	386	384	380	374	376	377	371	372	373	8661
Employment by Sector											
Agriculture/Farm	325	328	330	331	332	332	332	333	334	335	7103
Mining	1	1	1	1	1	1	1	1	1	1	12
Construction	12	12	11	11	10	10	10	9	9	9	292
Durable Goods	0	0	0	0	0	0	0	0	0	0	6
Non-Dur Goods	1	1	1	1	0	0	1	0	0	0	21
Tran & Util	6	6	6	6	6	6	6	5	5	5	132
Finan, Ins & RE	3	3	3	2	2	2	2	2	2	2	86
Wholesale	6	6	6	6	6	6	6	5	6	6	140
Retail	10	10	9	7	5	6	6	4	4	4	305
Services	18	19	17	14	12	13	13	11	11	11	515
State & Loc Govt	2	2	2	1	1	1	1	1	1	1	48
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	205.8	134.4
Real Disp Inc	136.4	92.4
Employment	8661	5622

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Biomass Scenario 3: Low Level, High Switchgrass Yield, Low Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	$7	$7	$6	$6	$6	$6	$6	$6	$6	$5	$5
Real Disp Inc	$6	$6	$5	$5	$5	$5	$5	$5	$5	$4	$4
Employment	287	276	263	256	250	240	238	236	233	230	226
Employment by Sector											
Agriculture/Farm	197	190	182	178	174	169	168	167	167	165	164
Mining	0	0	0	0	0	0	0	0	0	0	0
Construction	14	13	12	12	12	11	11	11	10	10	10
Durable Goods	0	0	0	0	0	0	0	0	0	0	0
Non-Dur Goods	2	1	1	1	1	1	1	1	1	1	1
Tran & Util	4	3	3	3	3	3	3	3	3	3	3
Finan, Ins & RE	6	6	5	5	5	5	5	4	4	4	4
Wholesale	5	5	5	4	4	4	4	4	4	4	4
Retail	22	21	19	19	18	17	16	16	15	15	14
Services	35	33	31	30	29	27	27	26	26	25	24
State & Loc Govt	3	3	3	3	3	2	2	2	2	2	2
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	5	5	5	5	5	5	5	5	5	5	119
Real Disp Inc	4	4	4	4	4	4	4	4	4	4	97
Employment	228	230	230	230	230	230	230	230	230	231	5035
Employment by Sector											
Agriculture/Farm	165	166	167	168	168	168	168	169	169	170	3602
Mining	0	0	0	0	0	0	0	0	0	0	1
Construction	10	10	10	10	10	10	10	10	10	10	226
Durable Goods	0	0	0	0	0	0	0	0	0	0	7
Non-Dur Goods	1	1	1	1	1	1	1	1	1	1	24
Tran & Util	3	3	3	3	3	3	3	3	3	3	62
Finan, Ins & RE	4	4	4	4	4	4	4	4	4	4	91
Wholesale	4	4	4	4	4	4	4	4	4	4	85
Retail	14	15	14	14	14	14	14	14	14	14	333
Services	24	24	24	24	24	24	24	23	23	24	552
State & Loc Govt	2	2	2	2	2	2	2	2	2	2	50
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	119.4	76.5
Real Disp Inc	97.2	62.8
Employment	5035	3220

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Biomass Scenario 4: Low Level, High Switchgrass Yield, High Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	$7	$7	$7	$7	$6	$6	$6	$6	$6	$6	$6
Real Disp Inc	$6	$6	$6	$5	$5	$5	$5	$5	$5	$5	$4
Employment	308	296	281	274	267	255	254	250	247	243	239
Employment by Sector											
Agriculture/Farm	213	206	197	193	188	182	182	181	180	179	177
Mining	0	0	0	0	0	0	0	0	0	0	0
Construction	15	14	13	13	12	11	11	11	11	10	10
Durable Goods	1	0	0	0	0	0	0	0	0	0	0
Non-Dur Goods	2	2	1	1	1	1	1	1	1	1	1
Tran & Util	4	4	4	4	4	3	3	3	3	3	3
Finan, Ins & RE	6	6	5	5	5	5	5	4	4	4	4
Wholesale	5	5	5	5	5	4	4	4	4	4	4
Retail	23	22	20	19	19	17	17	16	15	15	14
Services	36	34	32	31	30	28	28	27	26	25	23
State & Loc Govt	3	3	3	3	3	3	3	2	2	2	2
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	6	6	6	6	6	6	6	6	6	6	127
Real Disp Inc	4	4	4	4	4	4	4	4	4	4	100
Employment	241	243	243	243	242	242	243	241	242	243	5335
Employment by Sector											
Agriculture/Farm	178	179	181	182	182	182	182	182	183	183	3893
Mining	0	0	0	0	0	0	0	0	0	0	2
Construction	10	10	10	10	10	10	10	10	10	10	231
Durable Goods	0	0	0	0	0	0	0	0	0	0	7
Non-Dur Goods	1	1	1	1	1	1	1	1	1	1	24
Tran & Util	3	3	3	3	3	3	3	3	3	3	67
Finan, Ins & RE	4	4	4	4	4	4	4	4	4	4	91
Wholesale	4	4	4	4	4	4	4	4	4	4	90
Retail	14	14	14	14	13	13	13	13	13	13	331
Services	24	24	24	23	23	23	23	22	22	22	549
State & Loc Govt	2	2	2	2	2	2	2	2	2	2	50
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	126.5	81.3
Real Disp Inc	100.5	65.3
Employment	5335	3419

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Biomass Scenario 5: High Level, Low Switchgrass Yield, Low Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	$90	$87	$82	$80	$78	$73	$73	$71	$70	$68	$66
Real Disp Inc	$74	$71	$65	$64	$62	$57	$56	$54	$52	$50	$47
Employment	3732	3584	3382	3300	3218	3047	3031	2977	2924	2862	2792
Employment by Sector											
Agriculture/Farm	2643	2548	2441	2388	2335	2261	2250	2240	2229	2213	2192
Mining	2	2	2	2	2	2	2	2	2	2	2
Construction	170	163	150	146	141	129	128	122	117	111	105
Durable Goods	6	6	5	5	5	4	4	4	3	3	2
Non-Dur Goods	18	17	15	15	14	13	13	12	11	10	9
Tran & Util	53	51	48	47	46	43	43	41	40	39	38
Finan, Ins & RE	68	64	58	56	55	48	48	45	42	39	36
Wholesale	66	63	59	57	56	52	52	50	49	47	45
Retail	264	250	222	214	206	179	177	165	152	139	124
Services	404	384	348	337	326	290	288	271	254	237	218
State & Loc Govt	38	36	33	32	31	27	27	25	23	22	20
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	66	67	67	66	66	66	66	65	65	65	1495
Real Disp Inc	48	48	47	46	45	46	46	44	44	44	1109
Employment	2817	2842	2838	2825	2803	2812	2817	2788	2797	2806	62991
Employment by Sector											
Agriculture/Farm	2208	2224	2240	2250	2256	2256	2256	2261	2266	2272	48229
Mining	2	2	2	2	2	3	3	2	2	2	50
Construction	106	107	105	102	99	100	101	96	97	97	2490
Durable Goods	2	3	2	2	2	2	2	2	2	2	66
Non-Dur Goods	10	10	9	9	8	8	9	8	8	8	234
Tran & Util	38	38	38	38	37	38	38	36	36	36	863
Finan, Ins & RE	37	37	36	34	32	33	33	31	31	31	895
Wholesale	46	46	46	45	45	45	45	44	44	44	1045
Retail	127	130	124	117	109	111	112	102	104	105	3235
Services	221	225	216	207	196	199	201	189	190	191	5391
State & Loc Govt	20	20	19	18	17	18	18	17	17	17	493
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	1495.0	966.7
Real Disp Inc	1108.9	731.4
Employment	62991	40574

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Biomass Scenario 6: Slow Growth, Low Switchgrass Yield, Low Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	$9	$10	$11	$13	$14	$15	$16	$17	$18	$19	$20
Real Disp Inc	$7	$8	$9	$10	$11	$11	$12	$13	$14	$14	$14
Employment	373	430	473	528	579	609	667	715	760	801	838
Employment by Sector											
Agriculture/Farm	264	306	342	382	420	452	495	538	580	620	658
Mining	0	0	0	0	0	0	1	1	1	1	1
Construction	17	20	21	23	25	26	28	29	30	31	31
Durable Goods	1	1	1	1	1	1	1	1	1	1	1
Non-Dur Goods	2	2	2	2	3	3	3	3	3	3	3
Tran & Util	5	6	7	8	8	9	9	10	10	11	11
Finan, Ins & RE	7	8	8	9	10	10	11	11	11	11	11
Wholesale	7	8	8	9	10	10	11	12	13	13	14
Retail	26	30	31	34	37	36	39	40	40	39	37
Services	40	46	49	54	59	58	63	65	66	66	65
State & Loc Govt	4	4	5	5	6	5	6	6	6	6	6
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	21	23	24	25	26	28	29	30	31	33	432
Real Disp Inc	15	16	17	18	18	19	20	20	21	22	312
Employment	901	966	1022	1073	1121	1181	1239	1282	1342	1403	18305
Employment by Sector											
Agriculture/Farm	707	756	806	855	902	947	993	1040	1088	1136	14286
Mining	1	1	1	1	1	1	1	1	1	1	15
Construction	34	36	38	39	40	42	44	44	46	49	694
Durable Goods	1	1	1	1	1	1	1	1	1	1	17
Non-Dur Goods	3	3	3	3	3	4	4	4	4	4	63
Tran & Util	12	13	14	14	15	16	17	17	17	18	247
Finan, Ins & RE	12	13	13	13	13	14	15	14	15	16	241
Wholesale	15	16	17	17	18	19	20	20	21	22	299
Retail	41	44	45	44	44	47	49	47	50	52	852
Services	71	76	78	78	78	83	88	87	91	96	1459
State & Loc Govt	6	7	7	7	7	7	8	8	8	8	132
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	432.1	243.1
Real Disp Inc	311.7	178.6
Employment	18305	10264

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Biomass Scenario 7: High Growth, Low Switchgrass Yield, Low Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	$9	$13	$16	$19	$22	$24	$28	$30	$33	$35	$37
Real Disp Inc	$7	$10	$13	$16	$18	$20	$22	$24	$25	$27	$27
Employment	373	525	654	793	925	1025	1154	1269	1379	1480	1569
Employment by Sector											
Agriculture/Farm	264	369	464	561	654	735	832	929	1025	1117	1205
Mining	0	0	0	0	0	0	1	1	1	1	1
Construction	17	24	30	36	42	46	51	55	58	60	62
Durable Goods	1	1	1	1	1	1	2	2	2	2	2
Non-Dur Goods	2	3	3	4	5	5	5	6	6	6	6
Tran & Util	5	7	9	11	12	13	15	17	18	19	21
Finan, Ins & RE	7	10	12	15	17	18	20	21	22	22	22
Wholesale	7	9	11	14	16	18	20	22	23	25	26
Retail	26	38	45	55	64	68	75	78	80	80	78
Services	40	58	72	88	103	111	122	128	133	135	135
State & Loc Govt	4	5	7	8	10	10	11	12	12	12	12
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	40	44	46	49	51	54	57	59	62	65	795
Real Disp Inc	30	32	34	35	36	38	40	40	42	44	581
Employment	1707	1846	1969	2085	2192	2321	2448	2545	2674	2805	33738
Employment by Sector											
Agriculture/Farm	1313	1423	1534	1642	1748	1849	1951	2057	2164	2271	26107
Mining	1	1	1	2	2	2	2	2	2	2	24
Construction	67	72	75	77	79	84	89	89	93	97	1302
Durable Goods	2	2	2	2	2	2	2	2	2	2	32
Non-Dur Goods	6	7	7	7	7	7	8	7	8	8	122
Tran & Util	22	24	26	27	29	31	33	33	35	36	444
Finan, Ins & RE	24	26	26	27	26	28	30	29	30	31	464
Wholesale	28	30	32	34	35	37	39	40	42	44	551
Retail	84	91	92	92	90	96	100	96	100	105	1632
Services	145	156	159	161	161	170	179	176	183	191	2808
State & Loc Govt	13	14	14	14	14	15	16	15	16	17	253
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	795.1	432.3
Real Disp Inc	581.5	322.2
Employment	33738	18293

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Biomass Scenario 8: Slow Growth, High Switchgrass Yield, High Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	$9	$10	$11	$13	$14	$15	$16	$17	$18	$19	$20
Real Disp Inc	$7	$8	$9	$10	$11	$11	$12	$13	$14	$14	$14
Employment	373	430	473	528	579	609	667	715	760	801	838
Employment by Sector											
Agriculture/Farm	264	306	342	382	420	452	495	538	580	620	658
Mining	0	0	0	0	0	0	1	1	1	1	1
Construction	17	20	21	23	25	26	28	29	30	31	31
Durable Goods	1	1	1	1	1	1	1	1	1	1	1
Non-Dur Goods	2	2	2	2	3	3	3	3	3	3	3
Tran & Util	5	6	7	8	8	9	9	10	10	11	11
Finan, Ins & RE	7	8	8	9	10	10	11	11	11	11	11
Wholesale	7	8	8	9	10	10	11	12	13	13	14
Retail	26	30	31	34	37	36	39	40	40	39	37
Services	40	46	49	54	59	58	63	65	66	66	65
State & Loc Govt	4	4	5	5	6	5	6	6	6	6	6
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	21	23	24	25	26	28	29	30	31	33	432
Real Disp Inc	15	16	17	18	18	19	20	20	21	22	312
Employment	901	966	1022	1073	1121	1181	1239	1282	1342	1403	18305
Employment by Sector											
Agriculture/Farm	707	756	806	855	902	947	993	1040	1088	1136	14286
Mining	1	1	1	1	1	1	1	1	1	1	15
Construction	34	36	38	39	40	42	44	44	46	49	694
Durable Goods	1	1	1	1	1	1	1	1	1	1	17
Non-Dur Goods	3	3	3	3	3	4	4	4	4	4	63
Tran & Util	12	13	14	14	15	16	17	17	17	18	247
Finan, Ins & RE	12	13	13	13	13	14	15	14	15	16	241
Wholesale	15	16	17	17	18	19	20	20	21	22	299
Retail	41	44	45	44	44	47	49	47	50	52	852
Services	71	76	78	78	78	83	88	87	91	96	1459
State & Loc Govt	6	7	7	7	7	7	8	8	8	8	132
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	432.1	243.1
Real Disp Inc	311.7	178.6
Employment	18305	10264

4.5 Overview of Existing Wind Energy Technologies

As the demand for electricity increases and many of the existing fossil fuel and nuclear generating facilities are nearing the end of their life, additional sources of electricity are emerging. Wind energy offers one of the most promising sources for non-polluting, low-cost energy generation. In order to study the possibility of wind energy use in Iowa, we have examined technological, economic, and environmental issues related to wind energy.

There are a few critical technological issues that regulate wind energy use. Contrary to conventional wisdom, the wind energy output of a wind farm can be predicted with rather high confidence. If wind energy is ever to contribute a very large fraction of the electrical supply for a large region, then some form of storage or backup capacity will be needed to correct for the inevitable mismatches between wind-power output and demand. Sites of wind turbines need to be selected very carefully, because once turbines are installed, it is almost impossible to move them to other places to catch better wind resources. We have reviewed data regarding the mechanisms of wind-energy output, energy loss, reliability, and grid control.

The economic consideration of wind energy focuses on cost analysis. The overall production cost of wind energy, which is around 4-7¢ / kWh, is fairly competitive today and is down from about 25¢ / kWh in the early 1980's. Further efficiency improvements and cost reductions are possible. We have considered various estimates of construction and operation and maintenance (O&M) costs for the state of Iowa in order to provide a range of costs. Several analysts have conducted case studies to obtain a breakdown of costs for wind turbines of small (<50 kW), intermediate (50 to 200 kW), and large (>200 kW) sizes. Also, they have determined the costs of a 50-MW wind farm instead of single turbines, a form that is often advocated and that is in use in California and a number of foreign countries.

In Iowa, only biomass and wind are being seriously considered for renewable energy. The Iowa Energy Center is conducting a three-year project on wind energy in Iowa for the period of April 1993 - April 1996. Initial costs seem to be about $1,000/kW to install.

A total of 13 wind towers are being built in the state; several are now in operation. The unit which has the longest track record and the most operating data as a full production wind energy generator is the Waverly Light and Power unit. Following a preliminary feasibility study in 1991, and subsequent site evaluation and economic analysis, the Waverly wind-energy project was started in early in 1993 with plans for the installation of approximately 1 MW of wind capacity by 1996. The initial facility is an 80 kW wind turbine manufactured by Zond.

We spoke to Ben and Ken Hach at Zond and they said that the Zond equipment is being built and assembled in California, where Zond's headquarters is located. If a sufficient number of wind projects are started in Iowa, Zond may begin to assemble the parts in Iowa. Both for the wind-assessment projects (which use meteorology towers) and farms (which use generators), the equipment is built by the home company and then assembled and shipped to the site. In the case of generators, they are assembled from off-the-shelf parts. Presently there probably is no manufacturer and assembler of parts in Iowa.

A new 60 MW wind farm is also planned for Alta, Iowa. This will employ about 80 laborers during the construction period, which is expected to last for three to five months. The laborers will do masonry, hole digging, construction, electrical work, and build roads. Only four people will be brought in from California to consult on the project.

Zond leases land from farmers who get paid per acre as well as per tower constructed. In addition, the farmers owns "wind rights" that provide them with a percentage of energy based upon the amount of energy produced. If the land is sold or passed on to other family members, the contract will remain with the family.

From the Waverly final report (RLA Consulting, 1995), we find that the total cost of energy generation from the Waverly turbine, including turbine and tower, installation, land lease, and other related expenses, was $128,976, or $1,612/kW, which is somewhat higher than prevailing estimates. This seems to be within an acceptable cost range for the first turbine installed. With the plan for an eventual 1 MW capacity, they expect that economies of scale will lower the average cost. (Breakdown costs of Waverly turbine are listed at the end of this summary.) The overall energy cost of Waverly's current project (with a $25,000 grant) is about 11¢ / kWh. In the scenario with advanced technology, the electricity cost can be as low as 5.5¢ / kWh. To reach this cost level, much larger turbines (680 kW) will have to be used.

Because the Waverly turbine is located in a relatively low-speed wind area, the performance of the same wind turbine is expected to be higher and the energy cost would, then, be considerably lower (5¢ / kWh) in other sites in the north, where the wind resource are expected to be better.

The experience in wind-power output prediction obtained from the Waverly site shows that the actual monthly outputs are within a range from 83% to 117% of the predicted values. For the twelve months from October 1993 through September 1994, the actual output was five percent higher than the estimated output.

Waverly Turbine(80 kW)	**Costs($)**	
Turbine & tower	71,750	
Installation	19,950	
Related materials	16,073	
Fence & access road	5,552	
Underground tie line	8,800	
Land lease	2,200	
Consultants/legal	4,651	
Total	$128,976	Source: RLA Consulting, 1995

4.6 Construction of Scenarios for Wind-Generated Electricity

Modeling Approach

The statewide economic impacts of using wind energy plants, and the modeling of these impacts, occurs through three main channels:

1. Increased demand for purchases of wind power generation equipment, land and facility construction services.

2. Reduced demand for (imported) coal and existing coal-fired power plants in Iowa.

3. Electricity Cost Increases. Because electricity from wind is more costly than that from coal, electricity prices will have to be increased to finance the additional capital costs and operating costs.

Steps in Data Preparation and Development of Scenarios

The scenario and data inputs for REMI modeling are prepared in seven steps.

1. Obtain information on current total electric generation capacity (KW) and electricity production (KWh) in Iowa.

2. Obtain information on the percentage/amount of electricity generated from coal and its fuel requirement.

3. Assume a given percentage of coal (Btu) will be replaced by wind energy plants. We utilize several scenarios for a range of replacement percentages for period between 1995 and 2015.

4. Estimate capital and operating cost for wind power plants.

5. Estimate the impact of replacing coal-fired plants with wind energy, and calculate change in energy prices.

Construction of the resulting scenarios is summarized in Table 22 and text following it.

Table 22: Construction of Scenarios for Electricity from Wind energy

I. Wind energy Potential - Defining Scenarios

Percentage of kW generated by wind energy [1]	0.1%	0.3%	0.5%	1.0%
Million kWh	32.1	96.3	160.5	321

[1]Based on 1993 Iowa electricity generation estimate of 32.104 billion kWh. (Energy Information Agency, Electric Power Annual, 1993)

Wind Scenario	Replacement of Coal	Construction Cost	Operating Main. Cost	Financing
1	low	low	low	first year expense
2	high	low	low	first year expense
3	slow growth	low	low	continuing expense
4	high growth	low	low	continuing expense
5	high growth	mild	high	first year expense
6	high growth	high	high	first year expense
7	high growth	low	low	spread over 20 years as energy charge

II. Estimated Construction Costs (per kW Hour)

Source	Type of System	Estimate (original)	Estimate (1994$)
Wisconsin Energy Bureau (1994)	Wind Farm	$1000 (1992$)	$1059
Wisconsin Energy Bureau (1994)	Agricultural	$943 (1992$)	$999
Wisconsin Energy Bureau (1994)	Residential	$2700 (1992$)	$2965
Waverly Light & Power (1994)	80 kW	$1587 (1993$)	$1633
Carless (1993)	50-200 kW	$950-1100 (1990$)	$1095-1268
New York (1994)	Intermediate	$1073 (1992$)	$1136
General Estimate		$1200 (1992$)	$1271

III. Estimated Operation and Maintenance Costs (cents per kW Hour)

Source	Type	
Wis. Energy Bureau (1994)	30 MW Farm	1.0
Wis. Energy Bureau (1994)	Farm-scale Wind Machine	0.5
Wis. Energy Bureau (1994)	Resid.-scale Wind Machine	0.5
Brower (1992)	50-200 kW Turbine	1.5
Waverly Light & Power (1994)	80 kW Turbine	2.9
New York State (1994)	Wind Turbine	1.3

Additional Supporting Information:

Breakdown of Construction Costs of Wind energy Facilities (Percent of total spending in each category)

	30 MW Wind Farm	Large (200 kW) Turbine	Small Turbine
SIC 16	5%	----	14%
SIC 34	17%	21%	8%
SIC 35	44%	59%	35%
SIC 36	5%	4%	17%
Labor	29%	16%	26%

Sources: Wisconsin Energy Bureau, 1994; Johnson, 1985

Additional Estimates of Construction Cost Breakdown
(Percent of total spending in each category)

	50 MW Wind Farm	500 kW Turbine	80 kW Turbine
Turbines	86.0%		
Turbine and Tower	n.a.	85.0%	56.5%
Installation	n.a.	15.7%	
Tie line	n.a.	6.9%	
Drilling and concrete	n.a.	4.5%	5.0%
Access Road	n.a.	n.a.	2.9%
Fence	n.a.	n.a.	1.5%
Consultants	n.a.	n.a.	3.7%
Other	n.a.	3.0%	7.6%
Leased land	n.a.	n.a.	0.2%
Connection to grid	n.a.	7.5%	n.a.
Substation	6.6%	n.a.	n.a.
Transmission	0.6%	n.a.	n.a.
Service Center	0.5%	n.a.	n.a.
Land	3.9%	n.a.	n.a.
Permitting	2.5%	n.a.	n.a.
	100%	100%	100%

Sources: Union of Concerned Scientists 1992; Waverly Lighting and Power, 1994; Wortman, 1983

Note: All inputs are in 1987 dollars

Definitions of Scenarios

Wind Energy Scenario 1: **Low wind energy penetration; low construction costs; low O&M costs.**

1) Penetration of wind energy: 0.1% of total electricity for all years 1995-2015 (Net spending decrease of $1.98 million dollars for traditional energy sources).

2) Construction and payment for facilities of $6.1 million assumed to take place in 1995. Construction costs modeled using following split: 33% in SICs 15-17 (construction); 56% in SIC 35 (non-electric machinery); 7% in SIC 36 (electrical equipment); 4% in SICs 81, 87, 89 (professional services).

3) Added wind operation and maintenance costs are $0.21 million per year for each year from 1995-2015.

4) The difference between increased spending on wind-generated electricity and fossil-fuel-generated electricity was modeled as a decrease in local purchasing power (on other goods) of $4.35 million in 1995 and an increase in purchasing power of $1.77

million for each year from 1996-2015.

Wind Energy Scenario 2: High wind energy penetration; low construction costs; low O&M costs.

1) Penetration of wind energy: 1.0% total electricity for all years 1995-2015. (Net spending decrease of $19.8 million dollars for traditional energy sources).

2) Construction and payment for facilities of $61.24 million taking place in 1995.

3) Operation and maintenance costs are $4.61 million per year for each year from 1995-2000; and $2.92 for each year from 2001-2015.

4) The difference between increased spending on wind-generated electricity and fossil-fuel-generated electricity represents an increase in purchasing power of $10 million in 1995 and $11.68 million for each year from 1996-2015

Wind Energy Scenario 3: Slow growth of wind energy penetration; low construction costs; low O&M costs.

1) Penetration of wind energy: 0.1% of total electricity in 1995-1999; 0.2% in 2000-2004; 0.3% in 2005-2009; 0.4% in 2010-2014; and 0.5% in 2015.

2) Demand for electricity decreased by 0.1% ($19.8 million) in 1995-1999; dropping to $9.9 million by 2015.

3) Construction for new facilities ($6.1 million) is assumed to take place every fifth year, with payment usually spread over 5 years.

4) Operation and maintenance costs are $0.46 million per year for each year from 1995-1999; rising to $3.62 by 2015.

5) The difference between increased spending on wind-generated electricity and fossil-fuel-generated electricity is modeled as a decrease in local purchasing power, ranging from an $0.25 million loss in 1995 to a gain of $4.51 million in 2015.

Wind Energy Scenario 4: High growth of wind energy penetration; low construction costs; low O&M costs.

1) Penetration of wind energy: 0.1% of total electricity in 1995-1999; 0.4% in 2000-2004; 0.6% in 2005-2009; 0.8% in 2010-2014; and 1.0% in 2015.

2) Demand for electricity decreased by 0.1% in 1995-1999; 0.4% in 2000-2004; 0.6% in 2005-2009; 0.8% in 2010-2014; and 1.0% in 2015. Electricity spending decrease of $1.98 million dollars in 1995 -1999 rising to $19.8 million in 2015.

3) Construction and payment for new facilities assumed to take place every fifth year,

with $6.1 million in 1995, and$16.2 million in years 2000, 2005, 2010, and 2015.

4) Operation and maintenance costs are $0.46 million in 1995-1999; $1.67 for 2000-2004; $2.08 for 2005-2009; $2.67 for 2010-2014; and $3.62 for 2015.

5) The difference between increased spending on wind-generated electricity and fossil-fuel-generated electricity is modeled as a change in local purchasing power, ranging from an incremental loss of $4.6 million in l995 to a $14.0 million gain by the year 2015.

Wind Energy Scenario 5: **High wind energy penetration; mid construction costs ($1250 per kW); high O&M costs.**

1) Penetration of wind energy: 1.0% total electricity for all years 1995-2015

2) Demand for electricity decreased by 1.0% per year; decrease of $19.8 million.

3) Construction and payment for facilities of $75.41 million assumed in 1995.

4) Operation and maintenance costs are $5.41 million per year for each year from 1995-2000; and $2.92 million for each year from 2001-2015.
5) The difference between increased spending on wind-generated electricity and fossil-fuel-generated electricity is modeled as a decrease in purchasing power ranging of $61.02 million in 1995, and a gain of $16.88 million for 1996-2005.

Wind Energy Scenario 6: High wind energy penetration; high construction costs ($1600 per kW); high O&M costs.

1) Penetration of wind energy: 1.0% total electricity for all years 1995-2015

2) Demand for electricity decreased by 1.0% per year; decrease of $19.8 million.

3) Construction and payment for facilities of $96.52 million assumed for 1995.

4) Operation and maintenance costs are $5.41 million per year for each year from 1995-2000; and $2.92 for each year from 2001-2015.

5) The difference between increased spending on wind-generated electricity and fossil-fuel-generated electricity represents a decrease in purchasing power of $82.13 million in 1995, rising to a gain in purchasing power of $26.88 of the period of 2001-2005.

Wind energy Scenario 7: High wind energy penetration; construction and O&M costs charged as a constant increment in price per kW hour of usage; costs calculated using Iowa electricity prices and assumed capacity factor of 20%; initial capital cost of $1032 per kW.

1) Penetration of wind energy: 1.0% total electricity for all years 1995-2015

2) Demand for fossil fuel-generated electricity decreased by 1.0% per year or 321.04 million kWh. To calculate the decrease in spending on utilities, subtract 6.17 cents per kWh of replacement (fossil-fuel fired costs, including both operating and fuel costs), but then add 0.77 cents for each kWh wind energy to cover line losses. This decreases net energy production operating cost by 16.79 million dollars per year.

3) Construction and payment for facilities spread over all years. ($5.6 million/year) Construction costs modeled using following split: 33% in SICs 15-17; 56% in SIC 35; 7% in SIC 36; 4% in SICs 81, 87, 89.

4) Operation and maintenance costs are $4.32 million per year for each year from 1995-2015 and are assumed to stimulate demand for construction services.

5) The difference between increased spending on wind-generated electricity and fossil-fuel-generated electricity were modeled as a decrease in purchasing power of. $7.41 million per year for each year from 1995-2015.

4.7 Wind Energy Scenario Results

The cost data indicates that (at least in the short-term) wind energy appears to be a more financially realistic and technically feasible power source for Iowa than switchgrass. This conclusion, that wind costs can be expected to be lower than biomass combustion, was also found by a comprehensive study of the costs of alternative electricity generation technologies conducted by the New York State Energy Office.

It is, however, also important to note that wind and biomass energy do in fact affect the economy of Iowa in very different ways. In Iowa, use of switchgrass in electricity generation has the effect of replacing an imported good (coal) with one that is locally produced (switchgrass), using the same basic power plant boilers for co-firing switchgrass with coal. Thus, the Iowa economy benefits from keeping more dollars flowing in the state (known as"import substitution") and does not have to invest in any additional new power plant facilities to do so.

In contrast, use of wind energy does not increase demand for any local product except wind, which of course escapes the price system. With wind, there is still a much smaller substitution effect insofar as imports of fossil fuels will decline and there will be a modest increase in demand for construction services to maintain wind facilities. The largest effect on the Iowa economy associated with wind energy, though, is the financing and construction of new generating facilities. Funding for new capital investment of this type can have a short-term negative effect on the economy, to the extent that the funding reduces disposable income which otherwise would have been spent on other goods and services within the state. Of course, the savings on importing of coal into the state can then lead to longer-term benefits for the state economy.

Results for an aggressive scenario in which 1% of Iowa's electricity is generated by wind energy is represented by scenario 2. Under this scenario of low operating and capital costs, there is a substantial first year loss of jobs associated with the loss of income to pay for new generating facilities (which more than offsets the temporary construction jobs generated at that time). After that, there is a generally growing number of jobs generated, averaging 80 - 135 jobs/year over the period of 2005 - 2015. Associated with it is a net increase in personal income to Iowa residents of $2 - 4 million/year. Excluding the first year loss of jobs, these results indicate represent 1.6 jobs annually per million dollars spent on wind energy and $1.03 of income to Iowa residents for every $1.00 spent on wind energy. Compared to biomass, there are significantly fewer jobs created (since there is no ongoing crop harvesting impact) but overall income effects are as large or larger (due to money remaining in the Iowa economy rather than flowing to out-of-state coal suppliers).

Table 23: Economic Impact of Generating 1% of Electricity from Wind Energy

	Absolute Amount	Ratio: Per Million Dollars Spent	Percent Increase Over State Total
Change in Net Spending			
Total Over 10 yrs	$116 m	n.a.	n.a.
Average Year	$12 m	n.a.	n.a.
Peak Year	$61 m	n.a.	n.a.
Change in Jobs (excl. 1st yr.)*			
Total 10 yrs (Job-yrs)	292	2.5	<0.01%
Average Year	29	2.5	<0.01%
Peak Year	135	11	<0.01%
Change in Disposable Income (excl. 1st yr.)*			
(millions of constant 1994 dollars)			
Total Over 10 yrs	$7m	0.1	<0.01%
Average Year	$0.7m	0.1	<0.01%
Peak Year	$4m	0.3	<0.01%
Change in Gross State Product (excl. 1st yr.)*			
(millions of constant 1994 dollars)			
Total Over 10 yrs	$6m	0.1	<0.01%
Average year	$0.6m	0.1	<0.01%
Peak year	$5m	0.4	0.04%

* Including the losses of jobs and income associated with financing construction of new facilities, and the subsequent gains of jobs and income associated with wind plant operations, the net 20-year impact is approximately break-even. The figures shown here represent the average of the first ten years and the second ten years of operation.

Estimates of economic impacts for seven wind scenarios are presented in Table 24 (a - g). For each of the alternative scenarios, estimates of the employment impacts of wind energy penetration range from a loss of over 100 jobs per year (Scenario 7) to a gain of 100 jobs per year (Scenario 2). In Scenario 7, high wind energy penetration is assumed and construction and operation and maintenance costs are distributed based on consumption of wind-powered electricity. This essentially assumes that for every year between 1995 and 2015, around 320 million kW hours of electricity is generated from wind energy. Because construction costs are spread through the lifetime of the equipment in the form of electricity prices, the effects are fairly stable over time. The average effect is a loss of around 160 jobs per year and a loss of around 7 million in Gross State Product each year. This is a minuscule portion of the total Iowa economy.

TABLE 24: ESTIMATES OF ECONOMIC IMPACTS FOR EIGHT WIND SCENARIOS

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Wind 1: Low Level, Low Construction Cost, Low O&M Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	-3	0	0	0	0	0	0	0	0	0	0
Real Disp Inc	-5	0	0	0	0	0	0	0	0	0	0
Employment	-108	1	-2	0	-1	3	3	5	6	8	10
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	0	0	0	0	0	0	0	0	0	0	0
Construction	3	0	-1	0	0	0	0	0	0	1	1
Durable Goods	1	0	0	0	0	0	0	0	0	0	0
Non-Dur Goods	-2	0	0	0	0	0	0	0	0	0	0
Tran & Util	-5	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Finan, Ins & RE	-9	0	0	0	0	0	0	0	1	1	1
Wholesale	0	0	0	0	0	0	0	0	0	0	0
Retail	-43	1	0	0	0	1	1	2	2	3	3
Services	-47	2	1	2	1	3	2	3	4	5	5
State & Loc Govt	-5	0	0	0	0	0	0	0	0	0	0
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	0	0	0	0	0	0	0	0	0	0	-3
Real Disp Inc	0	0	0	0	0	0	0	1	1	1	-2
Employment	10	10	11	12	13	13	12	16	15	15	52
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	0	0	0	0	0	0	0	0	0	0	-5
Construction	1	1	1	1	1	1	1	2	2	2	16
Durable Goods	0	0	0	0	0	0	0	0	0	0	1
Non-Dur Goods	0	0	0	0	0	0	0	0	0	0	2
Tran & Util	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-23
Finan, Ins & RE	1	1	1	1	1	1	1	1	1	1	5
Wholesale	0	0	0	0	0	0	0	0	0	0	0
Retail	3	3	4	4	4	4	4	5	5	5	12
Services	5	5	6	6	7	6	6	7	7	7	43
State & Loc Govt	0	0	0	0	0	0	0	1	1	1	-1
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	-3.2	-3.8
Real Disp Inc	-1.9	-4.1
Employment	52	-30

IOWA STATE IMPACT OF ENERGY POLICIES
SCENARIO: Wind 2: High Level, Low Construction Cost, Low O&M Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	-33	-3	-4	-3	-4	-3	-2	-1	-1	0	0
Real Disp Inc	-53	-3	-5	-4	-4	-2	-2	0	0	1	2
Employment	-1097	-30	-52	-34	-43	-8	5	37	46	67	82
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Construction	24	-6	-9	-7	-8	-4	-2	2	3	5	7
Durable Goods	10	-1	-1	-1	-1	-1	-1	0	0	0	0
Non-Dur Goods	-25	0	0	0	0	1	1	1	2	2	2
Tran & Util	-46	-11	-12	-11	-12	-10	-11	-10	-10	-9	-9
Finan, Ins & RE	-87	-1	-2	-1	-1	1	2	4	5	6	7
Wholesale	4	-3	-4	-3	-4	-3	-2	-1	-1	0	0
Retail	-439	-6	-12	-7	-9	1	5	14	17	24	28
Services	-481	2	-6	1	-2	10	16	28	32	40	46
State & Loc Govt	-55	-2	-3	-2	-3	-1	-1	1	1	2	2
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	0	0	0	1	1	1	1	2	2	2	-45
Real Disp Inc	2	2	2	3	3	3	3	5	4	4	-39
Employment	83	82	93	105	116	111	105	138	131	135	72
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-46
Construction	7	7	9	10	11	11	10	14	13	14	110
Durable Goods	0	0	0	0	0	0	0	1	0	1	7
Non-Dur Goods	2	2	2	3	3	3	3	3	3	3	12
Tran & Util	-8	-9	-8	-8	-8	-8	-9	-7	-7	-7	-230
Finan, Ins & RE	7	7	8	8	9	9	9	11	10	10	20
Wholesale	0	0	0	1	1	1	1	2	2	2	-10
Retail	28	28	32	35	39	37	36	45	43	44	-16
Services	46	46	50	55	59	57	55	67	65	66	251
State & Loc Govt	2	2	3	3	4	4	3	5	4	5	-25
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	-44.8	-46.6
Real Disp Inc	-39.0	-54.7
Employment	72	-602

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Wind 3: Slow Growth, Low Construction Cost, Low O&M Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	0	-2	-2	-2	-2	0	-2	-2	-2	-2	0
Real Disp Inc	0	-2	-3	-3	-3	0	-3	-2	-2	-2	0
Employment	-10	-45	-47	-45	-46	-1	-45	-40	-36	-31	12
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	0	0	0	0	0	0	0	-1	-1	-1	-1
Construction	15	-6	-6	-6	-6	15	-6	-6	-5	-5	17
Durable Goods	2	0	-1	-1	-1	2	-1	-1	-1	0	2
Non-Dur Goods	-1	-1	-1	-1	-1	0	-1	-1	0	0	0
Tran & Util	-2	-2	-3	-3	-3	-3	-4	-4	-4	-4	-3
Finan, Ins & RE	-2	-3	-3	-3	-3	-1	-3	-2	-2	-2	0
Wholesale	4	-2	-2	-2	-2	4	-2	-2	-2	-2	4
Retail	-14	-13	-14	-13	-13	-11	-13	-11	-10	-8	-7
Services	-10	-16	-16	-15	-15	-5	-14	-12	-10	-8	1
State & Loc Govt	-2	-2	-2	-2	-2	-1	-2	-2	-2	-1	-1
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	-2	-2	-2	-1	0	-2	-2	-1	-1	0	-25
Real Disp Inc	-2	-2	-2	-2	1	-2	-2	-1	-1	0	-31
Employment	-29	-25	-20	-14	28	-14	-12	6	7	14	-393
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-14
Construction	-4	-4	-4	-3	19	-3	-3	-1	-1	17	14
Durable Goods	0	0	0	0	2	0	0	0	0	2	3
Non-Dur Goods	0	0	0	0	0	0	0	0	1	0	-5
Tran & Util	-4	-4	-4	-5	-4	-5	-5	-5	-5	-5	-81
Finan, Ins & RE	-1	-1	-1	0	1	0	0	1	1	0	-25
Wholesale	-2	-2	-2	-1	4	-2	-2	-1	-1	3	-8
Retail	-7	-6	-5	-3	-1	-3	-2	3	4	-6	-152
Services	-6	-5	-3	0	9	1	2	9	10	4	-99
State & Loc Govt	-1	-1	-1	-1	0	-1	-1	0	0	-1	-26
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	-25.4	-16.6
Real Disp Inc	-31.2	-21.3
Employment	-393	-304

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Wind 4: High Growth, Low Construction Cost, Low O&M Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	-3	0	0	0	0	-9	0	-1	0	0	-10
Real Disp Inc	-5	0	0	0	0	-15	0	0	0	0	-16
Employment	-109	-3	-5	-3	-4	-301	15	10	21	24	-317
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	0	0	0	0	0	-1	-1	-1	-1	-1	-1
Construction	2	-1	-1	-1	-1	5	1	0	2	2	2
Durable Goods	1	0	0	0	0	3	0	0	0	0	2
Non-Dur Goods	-2	0	0	0	0	-7	1	0	1	1	-7
Tran & Util	-5	-1	-1	-1	-1	-13	-3	-3	-3	-3	-16
Finan, Ins & RE	-9	0	0	0	0	-24	1	1	2	2	-24
Wholesale	0	0	0	0	0	1	0	-1	0	0	0
Retail	-44	-1	-1	-1	-1	-119	6	4	7	8	-123
Services	-48	0	-1	0	0	-131	10	9	13	14	-134
State & Loc Govt	-5	0	0	0	0	-15	0	0	1	1	-16
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	1	0	1	1	-11	2	1	2	2	-10	-37
Real Disp Inc	2	1	2	2	-16	4	3	5	4	-16	-46
Employment	63	53	65	69	-312	114	98	130	122	-294	-566
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-1	-1	-1	-1	-2	-2	-2	-2	-2	-2	-22
Construction	6	5	6	7	2	12	10	14	13	4	89
Durable Goods	0	0	0	0	2	0	0	1	1	2	12
Non-Dur Goods	2	1	2	2	-6	3	2	3	3	-6	-9
Tran & Util	-4	-5	-4	-4	-19	-6	-7	-5	-5	-20	-130
Finan, Ins & RE	5	4	5	5	-24	9	8	10	9	-22	-41
Wholesale	1	0	1	1	-1	1	1	2	2	-1	5
Retail	21	18	22	23	-120	37	33	42	40	-115	-264
Services	32	28	33	35	-128	55	50	61	58	-119	-163
State & Loc Govt	2	2	2	2	-16	4	3	4	4	-15	-43
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	-37.3	-23.2
Real Disp Inc	-46.2	-30.3
Employment	-566	-429

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Wind 5: High Level, Mid Construction Cost, High O&M Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	-39	-4	-4	-4	-4	-3	-2	-1	-1	0	0
Real Disp Inc	-64	-4	-5	-4	-5	-3	-2	0	0	1	2
Employment	-1333	-43	-63	-45	-54	-21	1	38	45	67	82
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Construction	32	-8	-11	-8	-9	-5	-3	2	3	5	7
Durable Goods	13	-1	-1	-1	-1	-1	-1	0	0	0	0
Non-Dur Goods	-30	0	0	0	0	0	1	1	2	2	2
Tran & Util	-53	-11	-12	-11	-12	-11	-11	-10	-10	-9	-9
Finan, Ins & RE	-106	-1	-3	-2	-2	0	2	4	4	6	7
Wholesale	6	-4	-4	-4	-4	-3	-3	-1	-1	0	0
Retail	-536	-10	-15	-10	-13	-3	4	15	17	24	28
Services	-590	-3	-10	-4	-7	5	15	29	32	40	45
State & Loc Govt	-67	-2	-3	-3	-3	-2	-1	1	1	2	2
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	0	0	0	1	1	1	1	2	2	2	-53
Real Disp Inc	2	2	2	3	3	3	3	5	4	4	-53
Employment	83	82	93	105	116	111	105	138	131	135	-224
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-46
Construction	7	7	9	10	11	11	10	14	13	14	112
Durable Goods	0	0	0	0	0	0	0	1	0	1	9
Non-Dur Goods	2	2	2	3	3	3	3	3	3	3	5
Tran & Util	-8	-9	-8	-8	-8	-8	-9	-7	-7	-7	-238
Finan, Ins & RE	7	7	8	8	9	9	9	11	10	10	-3
Wholesale	0	0	0	1	1	1	1	2	2	2	-9
Retail	29	28	32	35	39	37	36	45	43	44	-132
Services	46	46	50	55	59	57	55	67	65	66	118
State & Loc Govt	2	2	3	3	4	4	3	5	4	5	-39
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	-52.8	-54.3
Real Disp Inc	-52.5	-67.8
Employment	-224	-889

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Wind 6: High Level, High Construction Cost, High O&M Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	-48	-4	-4	-4	-4	-3	-2	-1	-1	0	0
Real Disp Inc	-79	-4	-5	-4	-5	-3	-2	0	0	1	2
Employment	-1675	-43	-63	-45	-54	-21	1	38	45	67	82
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Construction	46	-8	-11	-8	-9	-5	-3	2	3	5	7
Durable Goods	17	-1	-1	-1	-1	-1	-1	0	0	0	0
Non-Dur Goods	-38	0	0	0	0	0	1	1	2	2	2
Tran & Util	-64	-11	-12	-11	-12	-11	-11	-10	-10	-9	-9
Finan, Ins & RE	-134	-1	-3	-2	-2	0	2	4	4	6	7
Wholesale	10	-4	-4	-4	-4	-3	-3	-1	-1	0	0
Retail	-678	-10	-15	-10	-13	-3	4	15	17	24	28
Services	-747	-3	-10	-4	-7	5	15	29	32	40	45
State & Loc Govt	-84	-2	-3	-3	-3	-2	-1	1	1	2	2
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	0	0	0	1	1	1	1	2	2	2	-62
Real Disp Inc	2	2	2	3	3	3	3	5	4	4	-68
Employment	83	82	93	105	116	111	105	138	131	135	-566
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-46
Construction	7	7	9	10	11	11	10	14	13	14	125
Durable Goods	0	0	0	0	0	0	0	1	0	1	13
Non-Dur Goods	2	2	2	3	3	3	3	3	3	3	-3
Tran & Util	-8	-9	-8	-8	-8	-8	-9	-7	-7	-7	-249
Finan, Ins & RE	7	7	8	8	9	9	9	11	10	10	-31
Wholesale	0	0	0	1	1	1	1	2	2	2	-6
Retail	29	28	32	35	39	37	36	45	43	44	-274
Services	46	46	50	55	59	57	55	67	65	66	-40
State & Loc Govt	2	2	3	3	4	4	3	5	4	5	-57
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	-61.9	-63.5
Real Disp Inc	-68.2	-83.5
Employment	-566	-1231

IOWA STATE IMPACT OF ENERGY POLICIES

SCENARIO: Wind 7: High Level, High Construction Cost, High O&M Cost

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Results (1995 $)											
Gross Reg Prod	-10	-7	-8	-8	-8	-7	-7	-7	-7	-7	-6
Real Disp Inc	-14	-10	-12	-11	-11	-10	-10	-10	-9	-9	-9
Employment	-250	-173	-204	-185	-194	-167	-172	-162	-156	-148	-141
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
Construction	-19	-9	-13	-11	-12	-9	-9	-8	-7	-6	-5
Durable Goods	-1	0	-1	0	-1	0	0	0	0	0	0
Non-Dur Goods	-4	-3	-3	-3	-3	-3	-3	-3	-3	-2	-2
Tran & Util	-19	-15	-17	-16	-16	-15	-15	-15	-15	-15	-15
Finan, Ins & RE	-16	-12	-13	-12	-13	-11	-11	-11	-10	-10	-9
Wholesale	-7	-4	-5	-4	-5	-4	-4	-4	-3	-3	-3
Retail	-82	-59	-68	-63	-65	-57	-59	-56	-54	-51	-49
Services	-87	-60	-71	-64	-67	-58	-59	-56	-53	-50	-47
State & Loc Govt	-12	-9	-10	-9	-10	-8	-9	-8	-8	-8	-7
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	TOTAL
Results (1995 $)											
Gross Reg Prod	-6	-6	-6	-6	-6	-6	-7	-5	-6	-6	-144
Real Disp Inc	-9	-9	-9	-8	-8	-9	-9	-7	-8	-7	-197
Employment	-140	-140	-139	-136	-134	-140	-145	-114	-120	-117	-3279
Employment by Sector											
Agriculture/Farm	0	0	0	0	0	0	0	0	0	0	0
Mining	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-45
Construction	-5	-5	-5	-5	-5	-5	-6	-2	-3	-2	-153
Durable Goods	0	0	0	0	0	0	0	0	0	0	-3
Non-Dur Goods	-2	-2	-2	-2	-2	-2	-2	-2	-2	-2	-53
Tran & Util	-15	-15	-15	-15	-15	-15	-15	-14	-14	-14	-319
Finan, Ins & RE	-9	-9	-9	-9	-9	-9	-10	-8	-8	-8	-217
Wholesale	-3	-3	-3	-3	-3	-3	-3	-2	-2	-2	-75
Retail	-49	-49	-49	-48	-47	-49	-50	-41	-43	-42	-1132
Services	-47	-47	-47	-45	-45	-46	-48	-37	-39	-38	-1114
State & Loc Govt	-7	-7	-7	-7	-7	-7	-8	-6	-7	-6	-168
Federal Govt	0	0	0	0	0	0	0	0	0	0	0

TOTAL EFFECTS	**Sum of All Years**	**Net Present Value**
Gross Reg Prod	-143.7	-94.0
Real Disp Inc	-197.0	-129.4
Employment	-3279	-2176

Fuel Cost Results

One way to model the effects of a change from conventional to renewable energy is to estimate the effects on fuel costs and enter this into the model. However, the combination of relatively low potential penetration and small enough cost differences between conventional and renewable energy meant that even for the high penetration cases, there was little effect on electricity costs. However, we thought it would be worth exploring the effects of a radical change in electricity costs on the Iowa economy to get a sense of what would happen if a very ambitious or very costly renewable energy program were instituted. To test this, we ran two scenarios. In the first one, we model the effects of a 10% increase in the price of electricity to industrial consumers; in the second, the effects of a 10% increase to commercial consumers.

The results show that if electricity costs to commercial consumers were to increase by 10%, there would be a job loss of around 1,500 per year and a decline in Gross State Product (GSP) of $30 million to $180 million. A similar increase to industrial users would decrease jobs by 500/year and GSP by $5 million to $75 million. We can reasonably say, then, that an increase in electricity costs of 10% to commercial and industrial consumers together would decrease the number of jobs in the state by roughly 2000 / year and GSP by roughly $150 million per year.

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