# Statewide Economic Values of Alternative Energy Sources and Energy Conservation

David Swenson
Liesl Eathington
March 2002

A report for

**The Iowa Policy Project**

318 2nd Avenue North, Mount Vernon, Iowa 52314
319-643-3628 (phone) – 319-895-0022 (fax)
www.iowapolicyproject.org

**The Iowa Policy Project** Executive Summary

March 2002

# Statewide Economic Values of Alternative Energy Sources and Energy Conservation

By David Swenson & Liesl Eathington

Development of alternatives to traditional energy production has for many years held an attraction for those who want to move away from use of nonrenewable, polluting fossil fuels to generate electricity. The Governor's Energy Policy Task Force has proposed a legislatively established goal of achieving 1,000 megawatts (MW) of renewable energy generating capacity by 2010. This comes as Iowa utilities are preparing for or planning new electric generating stations fired by coal and natural gas. An expansion of alternative energy sources, to be considered seriously, requires a review of the economic implications of this alternative course.

This report estimates economic values associated with three energy scenarios. The first two entail alternative energy production in Iowa, while the third involves a set of energy conservation measures that have been compiled by state officials. These values are estimated using an input-output model of the Iowa economy. (See Page 2.) These economic results would be independent of health-cost reductions or environmental benefits due to better air quality, which we do not address.

The basics of the three analysis scenarios are, in summary:

- Isolating the total economic value associated with both current and near-term electricity production from wind sources in Iowa.
- Isolating the total economic value associated with substituting switchgrass for 5 percent of the average capacity from traditional coal-fired plants.
- Isolating the current-dollar savings to commercial establishments, institutions and households attributable to demand-side energy conservation measures implemented during the past decade.

## Scenario 1. Iowa's Wind-Energy Industries

Iowa is a desirable state for wind-energy production, ranking 10th nationally in potential. Developers are acting on this potential. Iowa has or soon will have 650 medium- to large-scale wind turbines, which will annually produce 1,554,785 megawatt-hours (MWh) of electricity. This production is equal to 3.6 percent of the total amount of electricity produced in Iowa in 2001. The following table shows the input-output model estimates of the direct, indirect and induced economic effects of investments in present and planned wind-energy production. (For an explanation of the input-output method of analysis, see the box on Page 2.)

---

**David Swenson** is a scientist in the Department of Economics at Iowa State University, where he specializes in rural economic studies, economic impact analysis, and assessments of state and local fiscal issues. He is also a private consultant who has in recent years conducted research on recycling industries in several U.S. states and cities, Iowa state and local finances and tax policy, and air transportation industries in the state.

**Liesl Eathington** is a research associate in the Department of Economics at Iowa State University. She compiles periodic reports on key aspects of the Iowa economy, and she is a data-management and GIS specialist. She also works periodically as a consultant specializing in data organization, analysis and presentation for decision-making and policy analysis.

This project was conducted privately for The Iowa Policy Project and should not be construed as an Iowa State University or a State of Iowa study.

**Table S1. Wind Energy Production: Total Economic Values**

| | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Total Industrial Output (sales)* | $ 116,526,782 | $ 43,224,373 | $ 16,082,438 | $ 175,833,593 |
| Labor Income | 2,466,200 | 17,811,540 | 6,016,411 | 26,294,151 |
| Value Added (inc. labor income) | 65,509,831 | 28,973,576 | 10,158,833 | 104,642,240 |
| Jobs | 65 | 519 | 268 | 852 |

*Total Industrial Output: gross sales of electricity, plus subsidies.

The study found that 1,554,785 MWh of wind-produced electricity produces $116.5 million in direct industrial output (gross sales of electricity and federal production subsidies). This includes $65.51 million in earnings to workers, payments to investors and indirect taxes, and 65 jobs. With spinoff effects seen from the input-output model of the Iowa economy, the industry can account for $175.8 million in total industrial output and 852 jobs.

### Scenario 2. Switchgrass to Energy

Electricity can be generated by co-firing switchgrass in a coal-fired power plant. Switchgrass, a perennial plant grown on conservation land or for forage or landscaping, has no clear market in Iowa. It has been promoted as an alternative energy source because it is environmentally sustainable and it will provide farmers an alternative crop option. This scenario, reported in Table S2, benefited from recent test-burn data at the Alliant plant near Ottumwa, Iowa, which was monitored by the U.S. Department of Energy and the Iowa Department of Natural Resources, and from recent Iowa State University research carefully accounting for the costs of switchgrass production in Iowa.

The 45 MW of switchgrass to electricity capacity, which at continuous production would be equivalent to a 38.25 MW capacity level, would create a demand for 274,013 tons of switchgrass annually. At this level of production, farmers would directly produce $16.3 million in industrial output, which would mean $6.4 million in payments to workers, farmers, and investors, and 331 jobs. Economic spinoffs included, this production would yield $26.6 million in

## What we're measuring: Economic values

In Tables S1-S3, values include both direct and spinoff effects. **Direct values** are amounts directly associated with the industry being studied. **Indirect values** include purchases by the industry and employment supported by them. **Induced values** result from spending by workers in the industry being studied and some spending by workers in the supplying firms. **Total values** are the sum of those categories. Information from the input-output model in this study measure:

- **Industrial output –** Generally, a measure of sales in a year. See footnotes with each table.
- **Labor income –** Workers' earnings and normal return to sole proprietors.
- **Value added –** Labor income (above) and investors' earnings.
- **Jobs –** Positions; most manufacturing jobs will be full time, full year; in the agriculture sector, many jobs will be part time or seasonal.

### Input-output modeling basics

Input-output modeling (I-O) is a method of economic analysis that helps us to understand the extent and value of transactions among industries, households, institutions, and with the rest of the nation and the world. An I-O model is an accounting of these transactions for a particular region. It is a static model that uses relatively current information about an economy to simulate how that economy reacts to changes in industrial output; returns to workers, owners, and investors or to changes in the regional supply of specific commodities. I-O models help us to quantify a range of industrial interactions and outcomes. For a full explanation of I-O modeling, see our full report at www.iowapolicyproject.org.

**Table S2. Switchgrass for Energy: Total Economic Values**

| | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Total Industrial Output (sales)* | $ 16,281,842 | $ 6,608,523 | $ 3,729,472 | $ 26,619,837 |
| Labor Income | 4,395,731 | 1,998,976 | 1,393,624 | 7,788,332 |
| Value Added (inc. labor income) | 6,377,662 | 3,573,036 | 2,350,424 | 12,301,121 |
| Jobs | 331 | 77 | 62 | 470 |

*Total Industrial Output: gross sales of switchgrass produced for energy.

industrial output considering all sectors of the economy and 470 total jobs. The major impact of substituting switchgrass for coal is to take dollars that were previously flowing to out-of-state coal producers and, instead, to put them in the pockets of Iowa farmers and others in Iowa who depend on the spending of those farmers.

### Scenario 3. Demand Management Energy Savings

For years the Iowa Utilities Board has documented savings to the state from energy conservation (demand-side energy management). In 2000, the IUB documented 1,027,352 MWh of energy savings from residential energy efficiency programs, nonresidential energy efficiency programs, and from load management practices. This savings value grows annually as businesses and households continue to adopt energy-saving practices and purchase energy-saving appliances.

**Table S3. Energy Conservation, 2000: Total Economic Values**

| | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Total Industrial Output* | $ 41,051,848 | $ 5,680,075 | $ 6,592,351 | $ 53,324,273 |
| Labor Income | 9,216,479 | 2,132,129 | 2,468,736 | 13,817,344 |
| Value Added (inc. labor income) | 15,610,813 | 3,190,561 | 4,155,323 | 22,956,696 |
| Jobs** | 423 | 79 | 111 | 612 |

*Total Industrial Output: energy conservation savings that were converted to household spending.
**The first three columns do not add to the total 612 due to rounding.

Of the 1,027,352 MWh in energy conserved, 20 percent (208,378 MWh) was for residential (household) programs, and 80 percent (818,874 MWh) was for nonresidential users. Energy conservation measures in 2000 saved residential users $16.8 million and saved nonresidential users $39.5 million.

These values were converted into residential savings and reduced business costs, which were then translated into higher returns for workers, owners and investors. When converted into household spending and entered into an input-output model of the Iowa economy, the kilowatt-hour savings yield the following economic outcomes: $53.3 million in total industrial output, $22.96 million in value added, which included $13.8 million in labor income, and 612 jobs.

## Key Findings

### *Alternative energy development offers an opportunity to retain and generate dollars in Iowa.*

In terms of industrial output, our analysis finds that every $1 million in wind-energy production (sales of electricity) supports $508,954 in spinoff sales in all other Iowa industries. This compares with a $244,811 spinoff effect for every $1 million in the industrial output of all other, mostly coal-fired, electricity production. An important factor in this difference is that all other electricity producers must obtain fuels – coal, fuel oil and natural gas – from outside of Iowa. Secondly, the price for wind includes a federal subsidy, and, third, the initial wind farms in Iowa received a price higher than the state, wind energy has a higher output multiplier – its spinoffs in the state economy are greater. There are only small differences in job and income effects between wind energy production and other electricity industries in Iowa, as demonstrated in Table S4. Because of this, policymakers may consider other grounds – including environmental and health aspects that we do not consider in this study – to encourage different energy production choices. The wind industry generates a similar number of jobs per $1 million of production as traditional utilities, but its average labor income per $1 million of industrial output is lower than for traditional utilities.

**Table S4. Wind Energy and Switchgrass Co-Firing vs. Other Electricity Industries in Iowa: Estimated Total Economic Effects Per $1 Million in Direct Output**

| | Wind Energy | Switchgrass | All Electrical |
|---|---|---|---|
| Total Industrial Output | $ 1,508,954 | $ 1,634,940 | $ 1,244,811 |
| Labor Income | 225,649 | 478,345 | 289,854 |
| Value Added | 898,010 | 755,512 | 971,093 |
| Jobs | 7.3 | 29 | 6.9 |

### *Alternative energy development will reduce demand for and burning of coal in Iowa.*

All of the energy scenarios reduce coal imports to the state. Not only does less money flow out of the Iowa economy to pay for the coal, but pollution from the coal is eliminated. We have left the analysis of environmental benefits to others, but we note that the decrease in coal use from the three scenarios is significant.

**Table S5. Out-of-State Coal Purchases Redirected Under Three Scenarios**

| | |
|---|---|
| Wind energy (3.6 % of total electric output) | 980,000 Tons |
| Switchgrass (45 MW co-fired with coal)* | 213,700 Tons |
| Energy Conservation programs existing in 2000 | 638,200 Tons |
| Total Coal Savings – Actual and Potential | 1,831,900 Tons |
| at $15/Ton = | **$27,478,500** |

*This figure reflects 38.25 MW of continuously used capacity. A new coal-fired plant operates 85 percent of the time. Thus, 45 MW of capacity fired by switchgrass translates to 38.25 MW of continuous operation.

### *Augmenting coal with switchgrass will not significantly affect costs to consumers.*

Switchgrass is more expensive, per unit of heat produced, than traditional fuels. At current costs of production, were a 900 MW capacity plant to include 45 MW of capacity co-fired by switchgrass, it would increase total fuel costs by 16.5 percent. Other costs of production would not increase, however, and the average increase in total electricity costs from such a plant would be just 2.1 percent. In order to make this option competitive with other, traditional forms of energy, it is likely that subsidies will need to be paid to producers of switchgrass or to the utilities using it. These subsidies might include permitted harvesting of switchgrass from Conservation Reserve Program (CRP) acres and a federal production tax credit.

### *Energy conservation saves Iowa residents and businesses millions*

Residential and non-residential energy efficiency programs already in place in Iowa have reduced energy consumption. The resulting money saved is freed up to be spent on other goods and services. Much of this spending accrues to Iowa businesses and residents; the end result is about $53 million in annual sales of goods and services in other sectors of the Iowa economy resulting from the savings in utility bills.

## Policy Conclusions – The Iowa Policy Project

This report demonstrates the economic effects that flow from the development of two alternatives to traditional energy production and from energy conservation measures already in place. The authors were commissioned by the Iowa Policy Project to make this economic assessment; they were not asked to make policy recommendations. Based on their study, the Iowa Policy Project makes the following conclusions and recommendations.

There are important benefits to the Iowa economy from developing renewable energy resources and expanding energy conservation. Direct spending inside the state by energy industries, their employees and their customers has direct effects and spinoff effects on other industries in the state economy. Policies that will encourage development of renewable energy and energy conservation will keep more Iowa dollars in the state, working for Iowans. Our recommendations:

**Increase the percentage that utilities should purchase or produce from renewable energy.**

Both wind-energy and switchgrass co-firing have been demonstrated to be workable energy strategies for Iowa, carrying potential for direct benefits and economic spinoffs. Growth in renewable energy would increase the benefit to the Iowa economy. Increasing the present state-established mandate for renewable capacity will benefit Iowa.

**Renew federal production tax credits for renewable energy.**

Federal production tax credits are important to current wind-energy generation in Iowa and to the economic values noted in the study. These expired at the end of 2001. A permanent loss of such subsidies could slow the development of wind sites in Iowa.

**Provide federal Conservation Reserve Program (CRP) payments for land where switchgrass is grown and harvested.**

At this stage in its development, the switchgrass industry requires extra-market support. Allowing Conservation Reserve Program participants to harvest their switchgrass crop for biomass could increase the potential participation of farmers. In addition, the federal production tax credit should be changed so it can apply to switchgrass.

**Encourage energy efficiency programs that lead to further savings in importation of fuel, especially coal.**

Energy efficiency programs not only save money for energy consumers, but provide them with more disposable income to spend in the state. Conserving energy also reduces the demand for coal imports.

**Gather information at the state level from wind generators about the costs of wind-energy production, and ensure reasonable public access to the portions of that information that are relevant to the formation of public policy**

Wind producers are receiving subsidies, and seek public policies that encourage further wind-energy development. For policymakers to make accurate decisions, producers should be required to open their books to regulators, just as investor-owned utilities are required to do.

## The Iowa Policy Project

**For the full report, see www.iowapolicyproject.org**

The Iowa Policy Project was founded in the summer of 2000 to produce and disseminate research on a broad set of issues of importance to the citizens of Iowa. We are a non-profit

The Iowa Policy Project

March 2002

# Statewide Economic Values of Alternative Energy Sources and Energy Conservation

By David Swenson & Liesl Eathington

Development of alternatives to traditional energy production has for many years held an attraction for those who want to move away from use of nonrenewable, polluting fossil fuels to generate electricity. The Governor's Energy Policy Task Force has proposed a legislatively established goal of achieving 1,000 megawatts (MW) of renewable energy generating capacity by 2010. This comes as Iowa utilities are preparing for or planning new electric generating stations fired by coal and natural gas. An expansion of alternative energy sources, to be considered seriously, requires a review of the economic implications of this alternative course.

## Introduction

This report estimates economic values associated with three energy scenarios. The first two entail alternative energy production in Iowa, while the third involves a set of energy conservation measures that have been compiled by state officials. These values are estimated using an input-output model of the Iowa economy. These economic results would be independent of health-cost reductions or environmental benefits due to better air quality, which we do not address.

The basics of the three analysis scenarios, including descriptions of the data used and assumptions, are developed fully in each section of this report. They are, in summary:

- Isolating the total economic value associated with both current and near-term electricity production from wind sources in Iowa.
- Isolating the total economic value associated with substituting switchgrass for 5 percent of the average capacity from traditional coal-fired plants.
- Isolating the current dollar savings to commercial establishments, institutions, and households attributable to demand-side energy conservation measures in the state implemented during the past decade.

In applying input-output analysis to these scenarios or policy outcomes, we must take great care to clearly define the kind of information that is developed from such an exercise and its appropriate uses. We must also differentiate these kinds of measures from other measures of economic gains.

---

**David Swenson** is a scientist in the Department of Economics at Iowa State University, where he specializes in rural economic studies, economic impact analysis, and assessments of state and local fiscal issues. He is also a private consultant who has in recent years conducted research on recycling industries in several U.S. states and cities, Iowa state and local finances and tax policy, and air transportation industries in the state.

**Liesl Eathington** is a research associate in the Department of Economics at Iowa State University. She compiles periodic reports on key aspects of the Iowa economy, and she is a data-management and GIS specialist. She also works periodically as a consultant specializing in data organization, analysis, and presentation for decision-making and policy analysis.

This project was conducted privately for The Iowa Policy Project and should not be construed as an Iowa State University or a State of Iowa study.

## Input-Output Modeling Basics

Input-output modeling (I-O) is a method of economic analysis that helps us to understand the extent and value of transactions among industries, households, institutions and with the rest of the nation and the world. An I-O model is an accounting of these transactions for a particular region. It is a static model that uses relatively current information about an economy to simulate how that economy reacts to changes in industrial output; returns to workers, owners and investors or to changes in the regional supply of specific commodities.

I-O models help us to quantify a range of industrial interactions and outcomes. I-O models are sometimes called “impact models” because they are used to quantify potential economic impacts attributable, for example, to industrial plant openings or closings in a region. We limit our use of the term *economic impact* in favor of the phrase *economic values*. When we quantify a set of economic values we are not necessarily implying causation on an economy-wide basis; instead, we are documenting a set of relationships using economic measures. The phrase “economic impact,” is frequently incorrectly used, and we are careful about using it. (For a full discussion of I-O modeling, see Appendix A)

## Scenario 1. Wind Energy

This scenario looks at the current economic value to the state of Iowa of existing wind-energy operations or those that are soon to come on-line. Large parts of Iowa are comparatively windy. The windiest portions of the state are desirable locations for the placement of wind turbines, and significant investment has occurred in recent years in the construction of wind farms. Cerro Gordo, Buena Vista, Worth and Hancock counties are currently prime sites, and are currently being developed. Other counties in the region are prime sites for growth, as well. There were several stages to our development of this scenario.

1. We accounted for a very large fraction of existing wind turbines in the state taking into consideration their locations and their sizes.
2. We also accounted for all known wind turbine developments that are either just coming on line or will in the near future. For these, too, we accounted for their placement and size.
3. We applied this information by project to the wind-energy calculator at ISU to determine the probable annual electricity generated by these machines. The wind-energy calculator allows us to fine-tune electricity generation estimates by generator type, size, height and actual location.
4. We reviewed the literature and field research data to determine characteristics of the industrial output of wind-produced energy in Iowa and elsewhere.
5. Estimates of capital investment costs, operation and maintenance costs, expected payrolls and jobs, rents paid to landowners, and expected returns to investors all in relation to a measure of the output value of wind-farm electricity in Iowa were determined from our research.
6. We estimated the expected amount of electricity that will be generated in Iowa for 2001 so that we could approximate the size of actual and near-term wind-energy production in Iowa.
7. Finally, we entered our wind-energy production values into the input-output model of the state of Iowa to determine the potential economic impacts of wind energy.

### Current or Planned Wind-Energy Production

Iowa is a desirable state for wind-energy production. It ranks 10th in wind-energy potential. Several firms have begun to capitalize on the state's capacity by investing in and constructing large wind farms in the counties of Buena Vista, Cerro Gordo and Kossuth, with more construction currently under way in Worth County. In all, most of the Northwest quadrant of the state has high wind-energy development potential. There are also a host of smaller wind-energy projects in school districts, municipal utilities and private firms. These, too, have been identified and added to our figures.

From our research we identified nearly 244,000 kW of wind-energy capacity in the state (see Table 1) as of late 2001. Over 98 percent of current wind-energy capacity in Iowa is found in large, utility-scale plants. Medium-size production, like the kind found in seven school districts in the state, accounts for 1.6 percent of the current capacity total, and all other small producers have just 0.18 percent. Proposed projects either just now coming on-line or which will in the next two years will more than double the state's wind-generating capacity by adding an estimated 263,000 kW. At the end of 2001 on into 2002, one of the proposed plants was brought on-line, so capacity at the beginning of 2002 is 324,040 kW. From known or planned projects, the state of Iowa will soon have 506,810 kW of installed wind-energy capacity. [1]

**Table 1. Iowa's Current and Proposed Wind Energy Capacity**

| Project Type | Capacity in kilowatts |
|---|---|
| Large (1 MW or Larger) | 239,700 |
| Medium (Schools, Hospitals, etc.) | 3,800 |
| Small (Commercial, Residential, etc.) | 440 |
| Subtotal, current | 243,940 |
| Large, proposed | 261,270 |
| Medium, proposed | 1,600 |
| Subtotal, proposed | 262,870 |
| Grand total | 506,810 |

Source: "Wind Project Data Base," American Wind Energy Association

Installed capacity, however, is misleading because the wind does not blow all of the time. In order to estimate mean electricity production from wind turbines, we need to know several things. Average wind speed in the locations of the turbines, the height of the turbines, the installed capacity of the turbines, and estimates of down time due to maintenance or repair must all be considered. We used the Wind Turbine Output Calculator, located on-line at the Iowa Energy Center, Iowa State University, to compile estimates of annual output from Iowa's wind turbines.

From our calculations, the medium- and large-scale projects in Iowa as of late 2001 produce nearly 787,085,300 kWh of electricity annually, which represents, we believe, 1.83 percent of year 2001's electricity production in Iowa. Our estimate of the total 2001 electricity production in Iowa is 43,123,709 MWh.[2] The 261,270 kW of planned installed capacity in large projects will generate an additional 767,700,100 of kWh of electricity. Although the planned installed capacity is greater than the amount currently on-line, it will generate slightly less electricity because, all other things considered, mean wind speed is slightly less in the new locations.[3] Using 2001 energy generation as our baseline value, both the existing and the proposed wind-energy production in Iowa will generate 1,554,785 MWh of electricity or 3.61 percent of our estimate of

---

[1] These figures include a proposed wind farm in Hancock County Iowa that would have 98 MW of installed capacity and would come on line in the year 2002. That project received approval from the Hancock County Board of Supervisors in the first half of 2000. This project was among the new wind projects identified in the "Wind Project Data Base," of the American Wind Energy Association, which was the primary source for existing and planned wind energy projects in the state.

[2] Our estimate of 2001 electricity generation was based on applying the 1993 to 2000 compounded annual rate of change to the amount generated in Iowa in year 2000. Although 2000 represented strong growth from the previous year, the current economic conditions, coupled with last year's high energy prices and a renewed push towards conservation, suggested that we use a more conservative growth figure; hence, the 1993 to 2000 rate.

[3] We used current installed turbine specifications on tower heights and capacities to compile our estimates. Actual future installations may, in fact, be different. We do not know the exact locations of all of the proposed wind farms, so the estimates of output may not reflect the optimal locations within the counties.

year 2001 energy production in the state of Iowa.

Establishing the Direct Economic Values of Wind Energy Production

Wind energy production is not a distinct industrial category in our input-output model. As it is technologically distinct in many regards from traditional electrical utilities, we can not rely on default values to help us to understand the overall economic importance of these firms to the state. As an alternative, we need to determine the social accounts of these firms in as much detail as possible. We then "shock" the model with the inputs that the firm needs for production along with the payments that are made to workers and to investors.

We were not able to find a detailed accounting of the operational costs of any existing wind farm in Iowa or the nation. Producers are incredibly secretive about operational characteristics. It is very hard to be an accountant when you cannot look at the books. We were, however, able to find broad summaries from several advocacy sources and the federal government that helped us to get a handle on some of the costs and returns of wind generation in Iowa. We also used Federal Energy Regulatory Commission reports (FERC Form No. 1) to ascertain information about utility purchases of wind energy in Iowa. These major assumptions are contained in Table 2.[4]

**Table 2. Wind Energy Direct Value Economic Assumptions**

| Item | Assumption |
|---|---|
| Total installed capacity for wind-generated electricity (current or under construction) | 506.81 MW |
| Total estimated production of the turbines in kWh | 1,554,785,352 kWh |
| Total installed cost for the turbines | $1,000 per kW of capacity |
| Annual lease payments to landowners | $2,000 per year per turbine |
| Annual maintenance & repair costs | 1 cent per kWh |
| Other annual operations/management costs | 8/10 cent per kWh |
| Employment | 1 maintenance worker per 10 turbines |
| Expected return to investors | 65 percent equity at 18% |
| Financing arrangements | 35 percent debt at 9.5% |
| Prices paid by utilities for wind energy | 5.795 cents per kWh |
| Other production subsidies | 1.7 cents per kWh |

These major assumptions have been used to develop the direct values that are contained in Table 3. It is also important to remember that we are measuring the current value of production in these plants and not the stream of production over the life of the plants. We determined that, at current prices paid for wind energy and subsidies received by producers, total industrial output would be $116.53 million. This value is derived primarily from the average 5.795 cents per kWh currently paid by utilities plus the government-funded production subsidies that we included at 1.7 cents per kWh[5].

---

[4] Detailed sources to these assumptions are contained in an appendix to this report.

[5] Though slated to sunset at the end of 2001, we have included the two main production subsidies, the Federal Renewable Energy Production Tax Credit, which is paid to investor owned utilities, and the Federal Renewable Energy Production Incentive, which is paid to municipal and other nonprofit utilities, at their most

We estimated payments to workers to be $2.47 million, payments to investors to be $61.3 million, and indirect tax payments to all governments at $1.75 million for total estimated 2001 value added at $65.51 million.[6]

**Table 3. Wind Energy Direct Economic Values**

| | | |
|---|---|---|
| Total Industrial Output | $ | 116,526,782 |
| Earnings | | 2,466,200 |
| Property Income | | 61,295,729 |
| Indirect Taxes | | 1,747,902 |
| Value Added | $ | 65,509,831 |
| Major Input Payments | | 24,422,049 |
| Finance Payments | | 25,296,902 |
| Lease Payments to Farmers | | 1,298,000 |
| All Other Payments | $ | 51,016,951 |
| Jobs | | 64.9 |

In producing wind energy, we estimated $51.02 million in production costs. Most of those costs were for finance payments of $25.3 million, followed by all other input payments, such as maintenance and repair, insurance costs, management and engineering fees, and other normal operation costs and payments, of $24.422 million. Annual payments to landowners are $1.3 million.

It is readily evident that this is a capital intensive industry. Like a traditional utility, only a small portion of the total industrial output goes to workers or to landowners. The value of capital-intensive industries, however, is often better measured in economic impact analysis by the industries' relationships to regional suppliers. If a capital intensive industry makes major purchases from the state economy for inputs, then that industry will have stronger linkages to the state's industrial structure. If a capital intensive industry must purchase its inputs from outside of the state, then that industry's linkages will be weaker.

The selling points of wind-energy production from an economic impact perspective include: (1) the payments made to landowners, (2) a marginal stimulus of new jobs, (3) existing or emerging linkages with input suppliers, and (4) wind is free. We can see from Table 3, however, that payments to workers and to landowners are very small, but that payments to suppliers are relatively high. For meaningful economic impacts to accrue in this industry, we would expect them to come primarily from the value of its linkages to industries in Iowa.

---

recent inflation-adjusted values. If these production subsidies are not renewed, we would lower the payments to investors by an amount equal to the subsidy. We would also expect that the absence of subsidies would slow the development of future wind sites in Iowa. At 5.7 cents/kWh, the payment for wind may be higher than future plants can expect. However, these are the only data available from a reliable source (FERC Form 1). To the extent that this price will fall over the life of the project, or to the extent that the law mandating utilities purchase renewables causes prices for existing wind turbines to be higher than for the new plants, our figures for economic values from wind will be overstated.

[6] Federal wind-energy production subsidies last for 10 years per eligible project/recipient. In addition, it is expected that the average price paid for kWh will decline significantly over time.

Wind Energy Total Economic Values

The major values in Table 3 were entered into our I-O model to estimate the statewide economic values produced by wind energy. There were two distinct I-O runs that were performed: The first entered all of the direct costs of wind-energy production into the model, the second translated all payments to workers, landowners and others into household spending. These data were then compiled to give us our estimates of the economic values that we would attribute to this form of energy production.

Table 4 lists the summary findings from the I-O model. All of the values in the direct column come from Table 3. In producing 3.6 percent of the state's electricity from wind, the industry will generate $162.1 million in industrial output (gross sales plus subsidies), pay $3.32 million in wages and salaries, create $91.64 million in value added, and require 65 workers. The much larger numbers in terms of labor incomes and jobs are found in the indirect and induced columns. We estimated that the industry would make $43.2 million in input purchase, which in turn would sustain $17.8 million in labor income and employ 519 workers. When workers in the direct and indirect industries converted their pay into household consumption, we would then get another $16.1 million in sales, $6.02 million in induced labor incomes, and an additional 268 jobs. This industry producing 3.6 percent of the state's electricity will account for $175.83 million in total industrial output in the state, ultimately support $26.3 million in labor incomes, produce $104.6 million in value added, and sustain 852 jobs.

**Table 4. Wind Energy Production Total Economic Values**

| | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Total Industrial Output | 116,526,782 | 43,224,373 | 16,082,438 | 175,833,593 |
| Labor Income | 2,466,200 | 17,811,540 | 6,016,411 | 26,294,151 |
| Value Added | 65,509,831 | 28,973,576 | 10,158,833 | 104,642,240 |
| Jobs | 65 | 519 | 268 | 852 |

As this is a capital intensive industry with very strong input requirements, the calculation of traditional multipliers of total values divided by direct values is somewhat misleading. Though the output multiplier would be $175.833 million ÷ $116.53 million = 1.51, a number that is generally similar to other industrial output multipliers, the labor income total multiplier would be nearly 11 ($26.3 million ÷ $2.47 million = 10.65) and the jobs total multiplier would be over 13 (852 ÷ 65 = 13.3). These kinds of multipliers are very misleading. Capital intensive industries are exceptional and often have very high income and job multipliers. As a rule, their multipliers should not be compared to other, less capital intensive industries.

An alternative and preferred measure of total, multiplied industrial value to the economy is arrived at by calculating total industrial outcomes per million dollars of direct industrial output. We have compiled those figures in Table 5 and we compare those figures for our wind-energy industries with the industrial average for all electricity production in the state.

**Table 5. Wind Energy Output Multipliers Compared with All Other Electricity Industries in Iowa**

| | Wind Energy | All Electrical |
|---|---|---|
| Total Industrial Output | 1,508,954 | 1,244,811 |
| Labor Income | 225,649 | 289,854 |
| Value Added | 898,010 | 971,093 |
| Jobs | 7.3 | 6.9 |

Our first multiplier is similar to the traditional output multiplier. Translated it means that for every million dollars in industrial output in the wind energy industries, $508,954 of sales in all other industries in the state are supported. Our analysis of Iowa wind-energy potential produced an output multiplier of $1.509 million in total output per $1 million in direct output in wind energy vs. $1.245 million in total output per $1 million in direct output for all other electricity production in the state. Most of that difference is because all other electricity producers must obtain their fuels (coal, fuel oil, natural gas) from suppliers outside of the state. As a consequence, they do not link strongly with the remainder of the state economy.

The next sets of multipliers compare economic outcomes per $1 million of direct industrial output. Due to all economic activity attributable to the wind-energy firms, we found $225,649 in labor income per $1 million of direct output compared with $289,854 for the entire electricity industry. Total value added in the state is $898,010 due to wind energy industries per $1 million of direct output compared to $971,093 in the remainder of the industry. Finally, the wind-energy industry produces 7.3 total jobs per $1 million of direct output compared to 6.9 jobs for all electricity producers in Iowa. This multiplier table is useful for future analysis for analyzing incremental gains in Iowa's wind-energy production as all of the values are indexed to $1 million in wind-energy output.

We now return to the output multiplier. One of the advantages to indigenous energy production is that it creates opportunities to retain dollars in the state. The logic is straightforward: If we can keep spending for energy from leaking out of the state, those retained dollars will help to sustain and stimulate Iowa's economy. This is an import substitution strategy for maximizing regional income, but it does not work unless the substitute is roughly competitive in price or quality with the product it is intended to replace. As wind energy becomes more prevalent and more efficient to produce, it has the capacity for replacing larger and larger fractions of traditional energy production, but because wind energy is intermittent, it in its own right creates logistical problems for energy generation in the state that must be addressed.

Still, we can figure out exactly how much coal is not purchased, for example, when the state achieves over 3.6 percent of electricity production from wind. Producing 3.6 percent of the state's electricity from wind energy will take the place of 979,776 tons of coal. Displacing that much coal reduces coal purchases by traditional utilities by $14,794,625 , when compared to a situation where there was no energy produced by wind.[7] In effect, then, wind energy forces a

---

[7] We calculated our coal savings based on last year's consumption and prices paid at the Alliant/IES Ottumwa Plant in Ottumwa, Iowa.

shift in spending (if measured in coal savings) of $14.8 million away from imports and toward an indigenously produced commodity. We will leave it to others to translate these coal reductions into air-quality conclusions, but an annual reduction of coal imports of $14.8 million is no trivial amount and does have consequences for the economy as a whole.

## Cautions and Considerations

As with any economic effects study, the conclusions are highly dependent on the quality of the data that we input into our modeling structure. It has already been mentioned that there is a dearth of specific information about the costs of wind-energy production in Iowa and elsewhere. Firms will not disclose their costs of operations, their gross receipts, or their payments to workers and investors. We have used a variety of sources to determine these data, but we recognize that some of our cost assumptions might be in error. We have concluded in our analysis that Iowa's wind-energy industry is maturing and would therefore behave like most Iowa industries as it sought goods and services. That means that, for example, the probability it received financing, management and engineering, maintenance and construction, and other essential services was roughly the same as other Iowa industries. If we have over-stated the regional purchase probability, then our results are inflated.

A large portion of the foundation for this analysis rests with the quality of data already compiled by the Iowa Department of Natural Resources and its intelligence on what is likely to happen in the next few years. Similarly, we have had to estimate wind-energy production using an on-line calculator. There is not enough external validation from actual wind energy farms to determine the overall accuracy of that calculator.

Finally, other studies have focused extensively on construction-level impacts or they have speculated that the impacts to the state would be higher were the manufacturers of wind turbines located in the state.[8] Construction costs are capitalized into ongoing (incremental) demand for capital goods and construction services in our model. They are dealt with, then, as an increment to construction demand and as annual payments for that capital investment. To use an I-O model to compile construction impacts is normally inappropriate because (1) it does not, other things being equal, generate more construction in the state relative to all other industry and household demand, and (2) construction effects are already measured in the input-output accounts so persons using this approach are double-counting economic activity.

Speculation as to whether economic impacts might be higher if wind technology were manufactured in the state poses somewhat of a different problem. It is somewhat analogous to Illinois farmers laying claim to all of John Deere's productivity or all Iowa laundries linking to Maytag. Were there a turbine manufacturer in the state supplying some meaningful number of turbines to Iowa wind farms, there would indeed be higher economic effects/impacts attributable to wind energy in Iowa, provided those turbines were the ones that were purchased. That same logic could be used for nearly any input commodity manufactured outside of the state. And we know

---

[8] See Steven Clemmer, "Strong Winds: Opportunities for Rural Development Blow Across Nebraska," Union of Concerned Scientists, February 2001.

that there is a lot of cross-hauling that nevertheless occurs in the state. Most Iowans, for example, do not own an Amana microwave. It is, however, a very distinct question as to the overall profitability and viability of wind energy in the United States as an energy source and whether wind-turbine manufacturing firms are or are not located within our state of scrutiny. We did not speculate as to the origins of the technology in our assessment, though we did conclude that there is sufficient density of investment in the state to suppose that there is also significant in-state engineering, managerial, maintenance and construction expertise to meet the needs of existing and planned wind-generation facilities in Iowa.[9]

---

[9] There is a very good compilation of economic impact steps to be considered in the National Wind Coordinating Committee's "Guidelines for Assessing the Economic Development Impacts of Wind Development." NWCC, October 2001. This compilation of guidelines is comprehensive in its outline and its considerations of kinds of information needed to conduct quality economic impact assessments of wind energy. These guidelines rely, ultimately, on access to good data about the detailed characteristics of wind-energy production. That publication, too, indicates that analysts should distinguish between short-term construction impacts and long term impacts. This notwithstanding, we still admonish all impact analysts to resist quantifying construction impacts without stating extraordinary justifications for doing so.

## Scenario 2. Switchgrass to Energy

This scenario calculates the statewide economic impacts that might accrue were the state of Iowa to generate electricity by co-firing switchgrass with coal in Iowa coal-fired plants. Elements of this have been studied over the years including a regional economic impact assessment considering switchgrass production in light of Conservation Reserve Program payment levels in Southern Iowa.[10] There has also been a demonstration test at the Alliant Ottumwa Plant near Ottumwa, Iowa, where nearly 1,300 tons of switchgrass were burned and the overall electricity production of the process assessed.[11] These studies have helped to lay the groundwork for determining much of the technical data needed to assess the economic impacts of switchgrass production for energy in Iowa. As with the previous analysis, there were several steps of preparation involved in the analysis.

1. Information about the Ottumwa plant test burn were obtained and analyzed for their generalizability and reliability in our analysis.
2. These preliminary findings were cross-checked with U.S. Department of Energy engineers to make sure that our conclusions about coal and switchgrass consumption at the plant were correct.
3. Based on these data we were able to estimate the number of tons of switchgrass that would be necessary to produce 38.25 MW of electricity continuously from this biomass source using the Ottumwa plant characteristics as our generation prototype.[12]
4. Once total needed switchgrass tonnage was determined, information was obtained from Iowa State University published research on costs and returns of switchgrass production.
5. Based on tonnage needs and assumptions about yield, we determined the total switchgrass output necessary to meet the 38.25 MW of continuous production goal.
6. These data were then entered into our input-output model to identify the statewide economic values that would accrue.

Our focus of analysis is at the farm level in this scenario, although we will itemize the difference in annual costs to utilities that would be evident were this scenario to be fully realized in the state. We have also treated the switchgrass production for energy as new agricultural productivity either emanating from Conservation Reserve Program acres or from other grassland that is suitable for switchgrass production. This is a relatively safe assumption as there is currently no clear market in the state for switchgrass, a perennial grass sown primarily for land stabilization but which has limited use as a forage.

---

[10] Mike Duffy and Virginie Y. Nanhou, "Cost of Producing Switchgrass for Biomass in Southern Iowa," Cooperative Extension publication PM 1866, Iowa State University, April 2001, and Dave Swenson and Dan Otto, "The Regional Economic Impacts of Switchgrass Production," Department of Economics, Iowa State University, Fall 1999.

[11] Jim Cooper, "Chariton Valley Switchgrass Project: Biomass to Energy," a presentation prepared by the Chariton Valley Rural Conservation and Development District, October 2001.

[12] Our assumption is to co-fire 5 percent of the average production of a 900 MW nameplate capacity coal-fired power plant. If such a plant were producing at 85 percent capacity, which would be the expected production level of a newer, state of the art plant, it would be producing, on average, 765 MW of electricity continuously. Five percent of that average production would require 38.25 MW from switchgrass.

From Coal to Switchgrass: Major Factors in Estimating Direct Economic Values

There are two primary justifications for investigating the utilization of biomass like switchgrass for energy production in Iowa. In the first case, biomass is sustainable, in the main, when compared to fossil fuel consumption. In the second, biomass production leaves an economic footprint on the state, whereas the importation of coal and other fuels for electricity results in Iowa dollars leaving the state. Issues associated with clean air and other environmental benefits we will leave to other analysts.

We are fortunate that we have recent data on the switchgrass to energy potential in Iowa. From these data we have been able to compile most of the important assumptions necessary for this assessment. Our primary assumptions necessary for compiling our direct data are found in Table 6.

**Table 6. Switchgrass Direct Value Economic Assumptions**

| **Item** | **Assumption** |
|---|---:|
| Ratio of Coal BTUs/lb to Switchgrass BTUs/lb | 1.28:1 |
| Coal needed to produce 38.25 MW | 24.4 Tons |
| Switchgrass needed to produce 38.25 MW | 31.3 Tons |
| Annual coal savings | 213,700 Tons |
| Annual switchgrass consumption | 274,013 Tons |
| Average price of coal per ton | $15.10 |
| Average cost per ton of switchgrass production | $59.42 |

Our starting point was learning about the comparability of switchgrass to coal. Research for the Chariton Valley RC&D district indicates that a ton of coal produces about 28 percent more BTUs than a ton of switchgrass. Using information from the Ottumwa plant's FERC Form No. 1[13] report we were able to ascertain the amount of electricity generated at the Ottumwa plant and the amount of coal that it used to do that. With that number we were able to determine that it would take 24.4 tons of coal to produce a continuous level of 38.25 MW of electricity. It would require 313.3 tons to replace that coal with switchgrass and produce continuously 38.25 MWh of electricity.

On an annual basis, then, 274,013 tons of locally-grown switchgrass would be required to replace 213,700 tons of imported coal.

In Table 6 we also indicate the difference in costs for the two commodities. Last year the Ottumwa plant paid $15.10 per ton of delivered coal. Our research indicates that using best management practices with an average expected yield of 4 tons per acre, it will cost $59.42 a ton to produce switchgrass, not including transport and storage costs to the utility[14]. That price includes all land and production costs along with reasonable returns to farm operators. It is clearly evident that the price per ton difference is stark. On a BTU-per-dollar basis, switchgrass

---

[13] Federal Energy Regulatory Commission. "Annual report of IES Utilities, Inc.," FERC Form No. 1, 2000, p. 403-F.

[14] This price is based on the costs of production and converting grassland into switchgrass production. Prices would be much higher if cropland were converted to switchgrass production.

is at least five times more costly than coal. At the end of this section we will calculate the expected cost difference per average consumer were this option to be realized in the state.

Table 7 lists the direct economic value estimates associated with producing 274,013 tons of switchgrass annually. At current costs, industrial output including returns to producers would be $16,281,842. Labor income would be $4.4 million, the vast majority of which would be returns to producers, and all value added (including labor income) would be $6.4 million. It will take the equivalent of 331 ag-sector jobs to produce this output.[15]

**Table 7. Switchgrass Production Direct Values**

| Economic Category | | Amount |
|---|---|---:|
| Total Industrial Output | $ | 16,281,842 |
| Labor Income | $ | 4,395,731 |
| Value Added | $ | 6,377,662 |
| Jobs | | 331 |

Assuming a yield of 4 tons per acre, the annual required tons would take at least 68,500 acres to produce. As it would be most profitable for producers relatively close to a plant to produce the biomass due to transport costs, it is immediately evident that the direct economic effects of switchgrass production and the total regional effects will be relatively robust and relatively concentrated in, say, a four- to eight-county region proximate to the consuming power plants.[16]

### Total Economic Effects of Switchgrass Production to Produce Energy

Our example supposes that 38.25 MW of electricity is produced continuously using a mixture of switchgrass and coal in a coal-fired power plant. Our economic assessment looks at the farm and regional economic values that would accrue if there were such a dedicated demand for switchgrass in the state. The results of the input-output analysis for this kind of production are contained in Table 8.

The direct data in Table 8 are the same as found in Table 7. In producing the $16.28 million of output, 331 ag-related jobs would be sustained and $4.4 million in labor income would be made. To produce $16.28 million of direct output, the switchgrass producers would purchase $6.61 million in indirect inputs, which would in turn support 77 additional jobs and $2.0 million in labor income. When all of the labor income is spent, we’d expect at least $3.73 million in induced household sales, which would support 62 more jobs and $1.4 million in induced labor income. Total economic activity associated with this production is $26.62 million in industrial output, $7.8 million in labor income, $12.3 million in value added (of which labor income is a subset), and 470 jobs.

---

[15] The employment values in this study measure jobs, not full-time employed persons, and reflect both full- and part-time and include seasonal positions in a farm economy.

[16] A new, 900 MW coal-fired power plant is slated for construction in western Iowa, just south of the Council Bluffs area, which may create another regional opportunity for the use of switchgrass for electricity in the state and concomitant regional benefits to farmers.

We have also listed the multipliers. As we are considering this to be new agricultural production we can claim potential economic impacts.[17] The multiplier of 1.63 means that for every $1 of output in switchgrass production in Iowa, $.63 in output is sustained in the rest of the economy. The labor income multiplier is 1.77. It means that for every dollar of labor income made in switchgrass production, $.77 in labor income is sustained in the rest of the economy. The jobs multiplier is 1.42. For every job involved in switchgrass production, 42/100ths of a job is sustained in the rest of the economy.

**Table 8. Switchgrass for Energy Total Economic Values**

Actual Values

| | Direct | Indirect | Induced | Total | Total Multipliers |
|---|---|---|---|---|---|
| Total Industrial Output | 16,281,842 | 6,608,523 | 3,729,472 | 26,619,837 | 1.63 |
| Labor Income | 4,395,731 | 1,998,976 | 1,393,624 | 7,788,332 | 1.77 |
| Value Added | 6,377,662 | 3,573,036 | 2,350,424 | 12,301,121 | 1.93 |
| Jobs | 331 | 77 | 62 | 470 | 1.42 |

**Total Values Per $1,000,000 of Direct Industrial Output**

| | Total |
|---|---|
| Industrial Output | 1,634,940 |
| Labor Income | 478,345 |
| Value Added | 755,512 |
| Jobs | 29 |

As we did in the wind-energy portion of this report, we list in Table 8 the total economic multipliers per $1 million of switchgrass production in Iowa. Total industrial output per $1 million of production would be $1.635 million after we consider all input purchases and all household purchases by workers. Per million dollars of direct output, switchgrass production would account for $.478 million in labor income, $.756 million in total value added (of which labor income is a subset), and 29 jobs.

### Switchgrass to Energy: Cautions and Conclusions

The output values that we have listed are based on good research on the costs of producing switchgrass in Southern Iowa. We are assuming that producers will recover their costs to include normal returns either in the purchase price or with some combination of direct subsidies to switchgrass producers or to electricity producers. Those, however, are political issues that must be addressed by others, as must the economic, environmental and political feasibility of such an option for energy production.

This analysis also does not look at whether there are meaningful opportunity costs to producing switchgrass. Our assumption has been that the switchgrass would be produced on land that has been seeded or would be seeded to grassland as would be the case for eligibility for the Conservation Reserve Program. There are of course alternative uses to this land that are not considered in this analysis.

---

[17] We would make this claim on an import substitution basis. We are also supposing that the conversion of grassland to switchgrass in and of itself was more profitable to landowners than other uses.

The switchgrass production economic activity that has been identified needs ultimately to be offset by the much higher prices paid by consumers per BTU of energy production in these plants. While the import substitution comparisons are evident, approximately $3.3 million in out-of-state coal purchases would be foregone, the absolute difference in prices paid for the two energy sources must be considered. If we assume, for example, that the delivered price of all of the necessary switchgrass to produce 38.25 MW of electricity hourly were $18.3 million (assuming $2 million in transport and storage costs), then the difference between the price paid by the utility for the two commodities has to be factored into increased business utility costs and reduced non-utility spending for homeowners. Such fine-tuning would help us to “net” the overall economic effects of such production.

Were the economic impact/value assessments to be truly fair, we would compare differences between gains to producers against assumptions about declines in household spending and business profits, assuming ratepayers paid all of the incremental costs. Were the production of switchgrass subsidized by federal spending, we would then assume that large portions of the cost differences would be socialized and therefore only affect ratepayers indirectly.

As there are potential economic, environmental and societal gains from requiring a fixed percentage of switchgrass consumption for energy, we can envision at least a couple of scenarios where the federal government could play a significant role in switchgrass production for energy. First, if we assume that the federal government would see its primary role as reducing greenhouse emissions and in soil protection, then it would have strong incentives to hold utilities otherwise harmless. The easiest way to do this would be the use of a tax credit that would allow for a subsidization of the price paid to farmers for switchgrass. Second, the federal government is already paying a large  fraction of farmers for soil conservation and crop stabilization under the existing Conservation Reserve Program. If the USDA were willing to make similar payments to switchgrass growers who harvested their crop for biomass, this could increase the potential participation of farmers.

Without considering any subsidies, just the fuel costs paid by utilities in producing electricity in a 900 MW plant would increase by as much as 16.5 percent were they to co-fire enough switchgrass to produce 5 percent of that capacity. The fraction of that increase that found its way to consumers, however, would be much less as all other costs of production would not increase. We calculated that if these cost increases were applied to the Alliant Ottumwa plant in 2000 given its electricity production, they would have increased the total cost of electricity from this plant by just 2.1 percent[18].

---

[18] These calculations were made using data from that plant’s Form No. 1 filing with the Federal Energy Regulatory Commission for year ending December 31, 2000, plus assumptions about average electricity energy production costs and payments to value added in total as compiled in our input-output model of that industry in the Iowa economy.

### Scenario 3. Demand Management Energy Savings in Iowa

The state of Iowa Utilities Board has documented demand-side management practices by electric utilities over the years. In the early 1990s, investor-owned utilities were required to make filings on energy conservation to the Iowa Utilities Board. Of late these data have been compiled "…from periodic, informal reports submitted by investor-owned utilities and from biennial reports submitted by consumer-owned utilities."[19] The Iowa Utility Board (IUB) staff caution us that

> …the data on utilities' program savings and benefits/costs do not represent analysis or extensive calculations performed on utilities' data by Iowa Utilities Board Staff. IUB staff merely compiled the results of the utilities' calculations, which were extracted from utility sources, and arranged the results into tables for ease of use.[20]

These cautions noted, we are nonetheless going to rely on these reports to estimate the potential economic value of these energy savings to Iowans.

There are references in the IUB reports to state administrative rules governing the determination of societal costs and benefits associated with these demand-side management programs that utilities have implemented over the years. As regional analysts, we are extremely cautious about using the language of benefit/cost analysis in areas where public investment is not at stake and good measures of consumer welfare gains are absent, as is the case in this example. Though there are utility-level investments or costs and an anticipated stream of energy savings benefits in the form of reduced demand for electricity and savings to business and home given a baseline situation, the data are not capable of clearly itemizing the costs nor the present value of the energy savings over time. Consequently, no reliable benefit-to-cost considerations (from a business investment perspective, not a consumer welfare perspective) from the research available for our review are possible.

The major categories for which energy savings data were compiled include:

- Residential energy efficiency (appliance rebates, primarily)
- Low-income programs (weatherization, for example)
- Non-residential efficiency incentives (commercial, industrial, institutional)
- Other miscellaneous programs
- Tree planting
- Residential load management
- Non-residential load management
- Other research and development programs

Our analysis will rely on the IUB spreadsheets of cumulative energy savings by broad category. We will use the input-output model to allocate those savings into total personal income and then allow those savings to be re-spent in the economy. Having done this we will simply isolate

---

[19] Gordon Dunn, Staff Memo: "Iowa Utilities Board energy efficiency database." Iowa Department of Commerce, Utilities Division, 24 August 2001, p. 1.

[20] Gordon Dunn, "Report on the Iowa Energy Efficiency Database – Part 2," Iowa Department of Commerce, Utilities Division, 24 November 1999, pp 1-2.

the economic impact potential of energy savings programs at the household level as if all of those savings translated into personal disposable income.[21]

Our steps in analysis were quite straightforward:

1. Electricity savings data from the IUB data sets were analyzed and organized to be meaningful for our purposes.
2. Mean residential and non-residential energy prices were applied to the cumulative savings values in the year 2000 so that a dollar amount of the savings to households and industry could be determined for that year.
3. Those values were then allocated proportionately into household spending and into the income portion of value-added in our input-output model of the Iowa economy.

Costs of Energy Conservation Programs

We are very aware that there are concomitant costs associated with energy savings; the economic effect of these costs, however, are nearly impossible to quantify. For example, qualifying investments made by business and industry may yield rebates along with reductions in associated federal and state tax liabilities due to the investment, the net of which are difficult to generalize without knowing a lot more about the industries for which energy savings conclusions have been drawn. Similarly, normal household replacement investment in heating, cooling and appliance efficiency may yield costs on the part of the utility in the form of rebates, which are then re-spent as disposable income by households. Both in the short run and the longer term, except for the transfer costs, there may be virtually no overall economic effect associated with these utility costs. This is not to infer that the costs are not important: Our tables will show that recent spending on these programs by investor-owned utilities was over $27 million in Iowa. But besides listing them, we do not analyze the economic effects of program costs in this scenario.

**Table 9. Investor-Owned Utility Energy Conservation Spending, 2000**

| Category | Spending | Percentage of Total |
|---|---:|---:|
| Residential Energy Efficiency | 6,369,174 | 23% |
| Low-Income Energy Efficiency | 296,715 | 1% |
| Non-residential Energy Efficiency | 8,567,965 | 31% |
| Other Miscellaneous | 44,937 | 0% |
| Trees | 111,342 | 0% |
| Other R&D | 1,119,471 | 4% |
| Residential Load Management | 3,496,652 | 13% |
| Non-residential Load Management | 7,604,412 | 28% |
| | 27,610,668 | |

Source: Iowa Utility Board database.

Table 9 shows an example of investor-owned utility spending for energy efficiency and conser-

---

[21] Our approach at the outset simply allocates energy savings as an increase in disposable income. While large fractions of savings accrue to non-residential customers, we have chosen to declare that those savings find their way directly into enhanced returns to workers, owners, investors, along with lower tax costs for maintaining public institutions. All of the values ultimately find their way into household accounts in the model.

vation programs in Iowa. Of the $27.6 million spent that year, over 59 percent was spent for non-residential energy efficiency or load management. The remainder is mostly allocated to residential savings.

Energy Conservation Direct Values

Table 10 gives us an idea of the savings for which we have accounted from the conservation programs. The first column details the estimated cumulative energy savings in MWh since accounting of these programs began. From the summary at the bottom, we have determined that 20 percent of the energy MWh savings have gone to residential consumers, while 80 percent have found their way to non-residential users (business, industry and institutions). Cumulative residential savings are 208,378 MWh, and savings to non-residential users are 818,974 MWh.

We determined the mean rate paid in Iowa by residential and non-residential users for electricity and applied those respective rates to the savings that have been claimed. Those values, too, are itemized in Table 10. The residential average rate in 2000 was 8.07 cents per kWh, and the weighted non-residential rate was 4.82 cents per kWh. By these calculations we have determined that the cumulative value of energy conservation savings in 2000 were $56.306 million. Residential savings were $16.8 million, and non-residential savings were $39.5 million. The residential share of savings (30 percent) are significantly greater than their share of MWh savings (20 percent) because residential users pay two-thirds more for their electricity than the average non-residential user.

**Table 10. Cumulative Energy Savings in MWhs and Dollars, All Iowa Utilities, 2000**

| | Cumulative Savings in MWh | Percent of Total | Average Revenue per kWh by Sector | Total Savings | Percent of Total |
|---|---|---|---|---|---|
| Residential Energy Efficiency | $ 194,984 | 19% | $ 0.0807 | $15,735,227 | 28% |
| Low-Income Energy Efficiency | 8,014 | 1% | 0.0807 | 646,764 | 1% |
| Non-Residential Energy Efficiency | 739,804 | 72% | 0.0482 | 35,672,094 | 63% |
| Other Miscellaneous | 72,397 | 7% | 0.0482 | 3,490,874 | 6% |
| Residential Load Management | 5,379 | 1% | 0.0807 | 434,085 | 1% |
| Non-Residential Load Mgment | 6,773 | 1% | 0.0482 | 326,565 | 1% |
| All Programs | $1,027,352 | | | $56,305,609 | |
| All Residential (Households) | 208,378 | 20% | $ 0.0807 | 16,816,076 | 30% |
| Residential Energy Efficiency | 818,974 | 80% | $ 0.0482 | 39,489,533 | 70% |
| All Programs | $1,027,352 | | | $56,305,609 | |

* Energy Information Administration, Form EIA-826, “Monthly Electric Utility Sales and Revenue Report with State Distributions.”

Our next task was to convert these savings into economic activity that could be entered into our input-output structure. We determined *a priori* that savings to households would result in a direct increase in disposable income. That amount is $16.8 million. The remaining savings to nonresidential customers accrue to businesses, industries, and governments. We have chosen to translate those savings into decreased business or government costs and, therefore, greater returns to labor, owners, and investors, which ultimately flow into households as income. A personal consumption rate is applied to the income estimates to further translate income into household consumption. The results of those calculations are contained in Table 11.

**Table 11. Total Change in Household Spending Due to Energy Conservation**

| | |
|---|---|
| Residential Savings | $ 16,816,076 |
| Non-Residential Savings Converted to Spending, by Income Source | |
| Earnings | 18,981,459 |
| Proprietor Profits | 3,421,076 |
| Earnings from Investments | 1,834,214 |
| Total Change in Household Spending | $ 41,052,825 |

Our assumptions in Table 11 are (1) non-residential energy savings all flow into the major components of value added (wages, profits, returns on investments) in the same proportions as exist currently from industrial production in the state,[22] (2) that only a minor portion of earnings from investments (19 percent) is converted into income,[23] and (3) a personal consumption rate of 83.2 percent was applied to the income estimates to translate income into household consumption.[24] Done thus, we find that nearly $41.1 million in energy savings have found their way ultimately into household consumption. This $41.1 million in potential household spending was then allocated to Iowa households in our model as household spending.

The Economic Values of Cumulative Energy Conservation

Table 12 contains the results of the input-output assessment. We determined that $41.1 million of the energy conservation values found their way into household spending in Iowa. That spending supported, initially, $9.2 million in labor income, $15.6 million in value added (of which labor income is a subset), and 423 jobs. As that direct spending worked its way through the Iowa economy, to include all suppliers to the directly stimulated firms and all residual worker spending, we find $53.3 million in total industrial output (sales), $13.8 million in labor income, $23.0 million in value added, and 612 total jobs.

**Table 12. Energy Conservation Total Economic Values, 2000.**

| | Direct | Indirect | Induced | Total | Total Multipliers |
|---|---|---|---|---|---|
| Total Industrial Output | 41,051,848 | 5,680,075 | 6,592,351 | 53,324,273 | 1.30 |
| Labor Income | 9,216,479 | 2,132,129 | 2,468,736 | 13,817,344 | 1.50 |
| Value Added | 15,610,813 | 3,190,561 | 4,155,323 | 22,956,696 | 1.47 |
| Jobs | 422.6 | 79.0 | 110.5 | 612.0 | 1.45 |

---

[22] These values were determined from the disaggregated Social Account Matrix of the Iowa economy that was constructed for this study.

[23] For lack of any other guideline this percentage represents the estimated receipt of investment income by Iowans from all sources as a percentage of all estimated investment income generated in the state. These data, too, were derived from the Social Account Matrix in the I-O model. Our assumption is that slightly over 80 percent of returns paid to investors in Iowa firms accrue to nonresidents.

[24] The ratio of personal outlay (consumption) to personal income derived from the "Survey of Current Business," Bureau of Economic Analysis, May 2000.

Multipliers appropriate to household spending are also included in Table 12. The industrial output multiplier of 1.30 means that for every dollar of increased household spending, $.30 of additional sales occur in the rest of the state economy. The labor income multiplier of 1.5 means that for every dollar in labor income paid to workers in the firms directly stimulated by the increase in household spending, $.50 in labor income is supported in the rest of the Iowa economy. The jobs multiplier of 1.45 means that for every direct job supported by this level of household spending, 45/100$^{ths}$ of another job is sustained in the rest of the economy.

Energy Conservation Economic Values: Cautions and Conclusions

It has already been mentioned that in regards to energy conservation, it is difficult to isolate all of the costs (many of the costs are simply transfers to homeowners and to businesses) and the final value of the gains in conservation. We have chosen to allocate savings into household consumption in Iowa. It must be noted that the quantification of “savings” can also be construed as reduced revenues to electricity providers. On an economic impact basis, then, we are simply shifting from one commodity (electricity) to another set of commodities (all other household consumption goods). The point to be made is that we are only looking at one side of the ledger (increased household spending) and not the other (reduced electric utility sales). There are, of course, other important factors including efficient capacity utilization, environmental enhancement, and increased production and household efficiencies that are important but are not quantifiable by our methods.

That said, the long-term gains to households, industries, and governments from investing in energy-efficient heating, cooling, and household appliances will yield significant energy savings over some baseline consideration. But our analysis does not consider either the incremental costs to householders or industries associated with these new investments.

There is one last consideration. There are two primary kinds of substitutions associated with the energy conservation practices measured in this section. In the first instance, utilities are helping to stimulate energy saving purchases within, presumably, the regional economy through their rebates and incentives programs. These might include new appliances, heating and cooling devices, landscaping, insulation and construction services. In the second instance, because of these purchases, there is a much lower demand for on-line energy and overall energy capacity than would have been the case had the purchases and improvements to homes and businesses not been made. Ultimately, homeowners have more money for other, non-energy purchases and businesses realize lower production costs and enhanced competitiveness. As a result of these outcomes, there are both direct and indirect purchases that are replacing imports of coal with locally supplied goods and services.

## Appendix A: Input-Output Modeling Basics

We generally limit our discussion of economic impact in this report to the following conditions:

- Additions or expansions of industries in a region that are producing goods primarily for export sales or contractions or losses of industries in a region that produce goods primarily for export sales. Examples include agriculture, mining, forestry, manufacturing, tourism and recreation, and regional concentrations of higher-order services or trade.
- The development of indigenous industries in a region that produce import-substitutes or the loss of indigenous industries in a region that previously produced import-substitutes. A great example is energy production, but any important industrial input or household item that can be produced locally when historically it had been imported fits into this category.
- Occasions where there is a significant and permanent investment in state or federal government facilities in a particular region. Examples here include military installations, public hospitals or other public facilities, prisons, along with educational institutions.
- Measurable changes in income and transfer payments to individuals that can be isolated regionally and quantified. Recent examples might include shifts in payments made to welfare recipients or Medicaid reimbursement rates to health care providers. We might also include in this list shifts in the amounts and kinds of aid to businesses and individuals. Changes, for example, in farm program or farm commodity payments could also fit into this category.

We use “base economy” foundations for classifying economic outcomes. A base economy foundation assumes that there are basic sectors of the economy that produce goods primarily for export and, as a consequence, generate income originating from outside of the production or study region. Non-basic sectors help to supply the input needs of the basic sectors as well as satisfy the overall consumption demands of workers and their households. When a set of economic activities appears to comply with the conditions above, we will use the term economic impact. When a set of economic activities does not appear to meet these conditions, then we are quantifying sets of economic interactions in a region that may not be causing changes in the rest of the economy. In these cases we use the term economic values.

The basics of input-output modeling are straightforward. The model is constructed ad-hoc for the study area in question. In the state of Iowa, the current set of I-O accounts allows us to differentiate among 420 industrial sectors along with seven household income levels. When a set of industrial values is introduced into the model that in one way or another indicates a change in industrial production, a change in particular demand for a specific kind of commodity, or a change in household income, then all of the other industries in the model adjust to the change. The I-O model accounts for these adjustments and summarizes them into tables. The kinds of information that we derive are measures of:

- **Industrial output**. This is usually the gross sales of a firm for a year or, in the case of a public-sector activity, the total expenditures of the entity. It is a measure that society one way or another places on the productivity or services of the entities that we are studying.
- **Labor income**. Labor income can further be subdivided into the earnings and salaries

of workers and the normal returns to proprietors.

- **Value added**. Value added includes labor income, above, but it also includes earnings by investors along with indirect tax payments to governments as, primarily, use, sales, and excise taxes.
- **Jobs**. For our industries we measure the number of jobs not the number of fully-employed persons. In manufacturing industries we know that nearly all of the jobs are full-time, full-year. In other sectors, like retail trade and recreation and tourism, many jobs are part-time or seasonal. In our model there is no differentiation among jobs – all are counted equally.

The tables differentiate the economic activity further into the

- **Direct values**. These are the amounts above that are associated directly with the industry that we are measuring.
- **Indirect values**. These are the amounts associated with all of the inputs that the direct firm requires. These could be raw commodities, manufactured goods, utilities, transportation, and other business or professional services.
- **Induced values**. These are the economic outcomes that result when workers in the direct industry and the increment to demand for workers that they cause in the supplying industries (the indirect values) spend their paychecks in the region. These values are also called household values or household effects.
- **Total values**. These are the sum of the direct, indirect, and induced values. They give us a duplicate accounting of transactions in the region that are attributable to the direct activity that we first measured.

When we have compiled these economic outcomes, we can then calculate the economic multipliers that are appropriate for the economic activity that we are measuring. For our purposes we are compiling a total multiplier.[25] This value is simply the total value divided by the direct value in any of the categories that we are reporting. It gives us the ratio of total economic activity to the direct activity that we are measuring.[26] It tells us how much the entire regional economy reacted per one unit change in the direct measure (a dollar of output, a dollar of labor income paid, a job, etc.)

---

[25] This is also known as a Type II, Type SAM, or an "impact" multiplier.

[26] Multipliers are another area where we have to deal with misapplication. Misapplication results from using inappropriate multipliers or assumptions. For example, if we introduce a new pork-packing plant somewhere in Iowa, the multiplier contains values associated with the total supply of swine the plant processes. To produce those hogs, there are requisite crop inputs, which in turn require their own list of production inputs. But the plant does not cause all of this agricultural activity, rather, some density of agricultural activity or capacity (superior corn and hog production) creates a supply sufficient enough that the plant can efficiently and competitively process for external sale. A packing plant, therefore, does not in and of itself create new agricultural activity in a region, though its multiplier accounts for the value of all of the industrial inputs and causation is, in fact, implied. If a plant closed in Iowa, there are not ratio-driven reductions in the production of hogs and, further on, corn, etc.

Misapplication also occurs when a multiplier is applied to the wrong industry. Each industry has its own set of inputs, and its own multiplier. Inappropriate multipliers also happen when a multiplier us used that is for a region that is different from the one that is being studied.

## Proper Applications of Input-Output Modeling

It is important at the outset to clarify proper applications of input-output modeling. The modeling process is designed to be applied to a discernible level of industrial output or some other factor that changes economic production in a region. This type of model should almost never be used to measure the short-term, localized economic outcomes associated with the construction of a facility. While there are alternative viewpoints on the value of that type of analysis, we choose an approach that ensures we will not overstate the effects. The industrial output of the entity already contains the amortized costs of its capital investment and an indirect impact or linkage with the region's construction sector. Despite this, many proponents of alternative energy projects, like wind energy, and other big-ticket items, like stadiums and convention centers, apply construction impacts to their advocacy positions.

The results of this kind of modeling do not determine the feasibility of a project or the expected returns. The returns to investors, for example, are input into the model, *a priori*, and are predetermined by existing industry averages. The returns that are reported are, therefore, predetermined in the construction of the model, not in the overall feasibility of the project or the assumptions that are used to determine feasibility. There are instances where declarations of economic values or potential economic impacts are inferred to mean that a project will be successful or is otherwise desirable to the regional economy. There is no information in an I-O model that determines the feasibility of an industry from a private or public investment standpoint.

There is, finally, inexact use of the term "economic benefits" when referring to the information derived from an I-O model. Benefits in a very strict sense refer to those gains to consumer welfare that accrue because of a specific set of public investments – a highway, a bridge, a tunnel, a navigation system, etc. They are usually the present value of a stream of societal gains that are compared to the present value of a stream of public costs. The economic values that are derived from an I-O model are not benefits in this sense and should never be referred to as such.

## Advantages and Disadvantages of I-O Modeling for Policy Making

As these models should not be used to describe big-ticket construction effects, can't be used to determine investment feasibilities, and do not inform us as to overall benefits, what good are they? I-O models give us highly detailed information about industrial production, income, and jobs. They help us to quantify and assess linkages among industries and households, and they allow us to quantify those values in readily understandable terms. Properly prepared and presented, the I-O models produce information that is useful to policy makers and advocates.

The I-O model is a simulation of the economy as it is currently configured. That means that all other things being equal we are measuring how the current economy reacts when demand is sparked. It is this currency that makes I-O models useful for decision making in the present, but not useful for forecasting.

Finally, the I-O model can be modified to compare a baseline case, the current model with an alternative situation. We could, for example, compare different sets of industrial growth in the state against a baseline case. We could do this by changing assumptions about costs, returns on investments, jobs, or the amount and kinds of inputs consumed in the model.

The model has limitations, too, that must always be acknowledged. Though its database is composed of industrial output, jobs, earnings, and other data that are collected nationwide either annually or every five years, there are inter-industrial coefficients that are dated. The newest I-O models are using inter-industry coefficients that were in evidence in 1997. Consequently, the incorporation of the value of technological advances into industrial production processes is always dated.

Similarly, the I-O model does not segregate emerging industries clearly. Industries associated with computer software and the integration of computers and computing capacity into industry and homes are subsumed in large part under a broad category of business services. Industries that are linked to specific aspects of telecommunications, both wired and wireless, as another example, are subsumed within a catch-all category called communications.

The model also cannot accommodate efficiencies or inefficiencies of scale without modification. Without knowing more information about an industry, the overall profitability, returns to workers and investors, and the amount and prices paid for inputs are constant whether the firm is large or small.

Finally, the model must rely on industrial-specific regional purchase coefficients (RPCs). These values tell us the likelihood that an industrial commodity or a household good will be purchased from an in-region supplier[*]. Overall economic values and potential economic impacts are very dependent the RPC values that are contained in the model. Knowing this, we do not change the model RPCs unless we have compelling evidence to do so.

---

[*] A good example involves access to investment capital. The model will indicate the likelihood that any financing – for a farm, a business, or a home – will be met by an in-state firm is the same for every industry and household. It may well be the case, however, that there are significantly different RPCs for farms, small or large businesses, and for homes. The only way to differentiate these possibilities further in the model is to delineate banking into sub-sectors for home, farm, and business finance. Such detail is either not possible or the aggregations are not reliable, in most instances.

## Appendix B: Wind Energy Information Resources by Major Category

Turbine Inventory
- Iowa Wind Energy Development, Wind Project Database, American Wind Energy Association.
- Iowa Wind Projects, Wind Energy Manual, Iowa Energy Center.
- Operating Facilities by Technology in the State of Iowa, from the Renewable Plaint Information System, National Renewable Energy Laboratory.
- Wind Turbine Sites in the Midwest, www/windustry.org.

Lease Payments
- “Wind Energy and Economic Development: Building Sustainable Jobs and Communities,” Wind Energy Fact Sheet, American Wind Energy Association.
- Memorandum from Kenneth R. Hach, Enron Wind Development Corporation, dated November 2, 1999.

Installation Costs
- “Exploiting Wind Versus Coal,” SCIENCE, Vol. 293, August 24, 2001, by Mark Z. Jacobson and Gilbert M. Masters, Department of Civil and Environmental Engineering, Stanford University, Stanford, CA.
- “Wind Energy Costs,” National Wind Coordinating Committee, Wind Energy Series No. 11, January, 1997.

Financing Arrangements
- “Wind Power Costs Depend on Ownership, Financing,” from Wind Energy Weekly #709, 12 August 1996, reprinted in “Wind Energy Frequently Asked Questions: What are the factors in the cost of electricity from wind turbines?” American Wind Energy Association.
- Memorandum from Kenneth R. Hach, Enron Wind Development Corporation, dated November 2, 1999.

Operations and Maintenance Costs
- “Review of Operation and Maintenance Experience in the DOE-EPRI Wind Turbine Verification Program,” presented at the American Wind Energy Association’s WindPower 2000 Conference, May, 2000, by K. Conover, J. VandenBosche, and H. Rhoads of Global Energy Concepts, LLC, and B. Smith of the National Renewable Energy Laboratory.
- “Operation and Maintenance Costs for Wind Turbines,” Danish Wind Industry Association, www.WINDPOWER.org.
- “Wind Energy Costs,” National Wind Coordinating Committee, Wind Energy Series No. 11, January, 1997.
- “Lessons Learned at the Iowa and Nebraska Public Power Wind Projects: U.S. Department of Energy – EPRI Wind Turbine Verification Program, American Public Power Association DEED Program,” Electric Power Research Institute, Abstract from Report 1000962, December, 2000.
- “Storm Lake, Iowa, Wind Power Facility Project Information,” Case Studies, Enron Wind Development Corporation.

Turbine Output
- Wind Turbine Output Calculator, Iowa Energy Center.
- Iowa Wind Energy Development, Wind Project Database, American Wind Energy Association.
- Renewable Energy Production Incentive Payments, Office of Power Technologies, U.S. Department of Energy.

Wind Power Purchase Price: FERC Form No. 1, Federal Energy Regulatory Commission, p. 326-7, annual reports filed by MidAmerican Energy Company, IES Utilities, and Interstate Power Company for 2000.

## Appendix C: Wind Energy Sites in Iowa Currently Producing Electricity or Proposed as of November 2001.

| Type | Facility | City | County | Turbine type | Tower height (meters) | Turbine size (kW) | No. Turbines | Total Capacity (kW) | Estimated Output* (kWh) |
|---|---|---|---|---|---|---|---|---|---|
| LC | Municipal Utilities Cooperative Project | Algona | Kossuth | Zond Z-50 | 50 | 750 | 3 | 2,250 | 6,495,102 |
| | Storm Lake Wind Power Facility / MidAmerican | Alta | Buena Vista | Zond Z-50 | 63 | 750 | 150 | 112,500 | 372,096,779 |
| | Storm Lake Wind Power Facility / Alliant | Alta | Buena Vista | Zond Z-50 | 63 | 750 | 107 | 80,250 | 265,429,036 |
| | Storm Lake Wind Power Facility / Waverly Light & Power | Alta | Buena Vista | Zond Z-50 | 63 | 750 | 2 | 1,500 | 4,961,290 |
| | Cerro Gordo Wind Farm | Clear Lake/Ventura | Cerro Gordo | NEG Micon 48WTGs | 55 | 750 | 56 | 42,000 | 127,646,820 |
| | Sibley Wind Farm | Sibley | Osceola | NEG Micon M15-600/150 | 46 | 600 | 2 | 1,200 | 3,356,669 |
| LP | Top of Iowa Wind Farm I | Joice | Worth | NEG Micon NM900/52 | 65 | 900 | 89 | 80,100 | 229,707,315 |
| | Top of Iowa Wind Farm II | Kensett | Worth | NEG Micon NM900/52 | 65 | 900 | 89 | 80,100 | 229,152,925 |
| | Sibley Hills | Sibley | Osceola | Vestas V47 | 48 | 660 | 2 | 1,320 | 4,129,432 |
| | Hancock County Wind Farm | Britt | Hancock | NEG Micon 48WTGs | 55 | 750 | 133 | 99,750 | 304,710,411 |
| MC | Private owner | Britt | Hancock | Windmatic | 50 | 65 | 3 | 195 | 504,219 |
| | Schafer Systems, Inc. | Adair | Guthrie | Vestas V27 | 50 | 225 | 1 | 225 | 490,000 |
| | Akron-Westfield School District | Akron | Plymouth | Vestas | 50 | 600 | 1 | 600 | 1,406,117 |
| | Goldfield School District | Clarion | Wright | AOC 15/50 | 50 | 65 | 1 | 65 | 163,943 |
| | Sentral School District | Fenton | Kossuth | Windmatic | 50 | 65 | 1 | 65 | 170,278 |
| | Forest City School District | Forest City | Winnebago | Nordex | 50 | 600 | 1 | 600 | 1,300,000 |
| | WindWay Technologies | Joice | Worth | WindWay | 50 | 300 | 1 | 300 | 794,316 |
| | Nevada School District | Nevada | Story | WindWorld | 50 | 250 | 2 | 500 | 350,000 |
| | Story County Hospital | Nevada | Story | Vestas V29 225 | 50 | 225 | 1 | 225 | 157,500 |
| | Clay Central/Everly School District I | Royal | Clay | | 50 | 95 | 1 | 95 | 117,800 |
| | Clay Central/Everly School District II | Royal | Clay | | 50 | 600 | 1 | 600 | 1,300,000 |
| | Spirit Lake School District | Spirit Lake | Dickinson | Wind World 250 | 50 | 250 | 1 | 250 | 250,000 |
| | Waverly Light and Power | Waverly | Bremer | Vestas/Zond | 50 | 80 | 1 | 80 | 95,400 |
| TOTAL | | | | | | | 649 | 504,770 | 1,554,785,352 |

LC = Large facility, currently in operation
LP = Large, proposed or under construction
MC = Medium-sized facility, currently in operation

* All output estimates from the Iowa Energy Wind Turbine Output Calculator were made using a loss factor of 12 percent.

** Turbine specifications were insufficient to make output estimates using the Iowa Energy Center Wind Turbine Output Calculator. Other data sources were used for these estimates (see Appendix B: Wind Energy Information Resources by Category).

Source: "Wind Project Data Base," American Wind Energy Association, November 2001, and the Iowa Department of Natural Resources.