# Wisconsin Public Service Corp.

## Wise Buys Irrigation Program

## Profile #44

# Executive Summary

Wisconsin Public Service Corporation's Irrigation Program is a pump testing and incentive program for agricultural customers who install reduced pressure irrigation systems. These systems typically operate at 50-65 pounds per square inch (psi) with 60 to 75 horsepower motors to deliver 1,000 gallons per minute. Conventional systems operate at about 100 psi with 100 horsepower motors to deliver the same volume of water.

In order to promote the reduced pressure irrigation systems, WPSC first needed to overcome farmers' misconceptions about reduced pressure systems. WPSC recognized from the onset of the program the value of working with trade allies and the University of Wisconsin Cooperative Extension Service to introduce these energy-efficient technologies. It is this partnership that has been responsible for the changing attitudes toward reduced pressure irrigation systems in Wisconsin and that has made this program a success to date.

To implement the program, WPSC relies heavily on trade allies. Equipment dealers in the WPSC service territory actively promote the program with their high levels of customer contact and credibility. Utility rebates of up to $300 generally cover 100% of the cost of a required pump test, performed by the equipment vendors. Then WPSC provides incentives for irrigation system components, including new motors, based on estimated demand reductions. In turn the rebates available through the Irrigation Program boost vendors' sales by encouraging customers to make purchases of equipment that might otherwise be unaffordable.

A typical irrigation system retrofit entails the purchase and installation of new sprinkler nozzles, a new downsized motor for the pump, and a rebuilt pump. Thirty-nine reduced pressure irrigation systems were installed on 31 different wells between 1990 and 1992. In 1992, the Irrigation Program resulted in energy savings of 411 MWh. WPSC estimates that about one-half of the 385 wells eligible to participate in the program have terrain and well volumes suitable for reduced pressure irrigation systems. Of these, another half have barriers to implementation such as inappropriate crop type(s), or stringent buyers' rules regarding crop irrigation. Thus, there are approximately 96 wells being targeted by the Irrigation Program, and about one-third have already been reached.

A typical retrofit costs $8,000 to $10,000, and WPSC rebates can cover anywhere from 20% to 100% of the cost, depending on the characteristics of the existing system and the retrofit. In 1992, total installation costs (including pump tests) for the 29 systems installed were $504,000. WPSC covered $173,500 of those costs, and customer contributions totaled $330,500.

### Irrigation Program

| | |
|---|---|
| Utility: | Wisconsin Public Service Corp. |
| Sector: | Agricultural |
| Measures: | Reduced pressure irrigation systems; high-efficiency pump motors and pumps |
| Mechanism: | Cash incentives for pump tests and system installation |
| History: | Pilot in 1989, 39 systems installed through 1992. |

**1992 Program Data**

| | |
|---|---|
| Energy savings: | 411 MWh |
| Lifecycle energy savings: | 6,165 MWh |
| Capacity savings: | 0.700 MW |
| Cost: | $182,800 |

**Cumulative Data (1990 - 1992)**

| | |
|---|---|
| Energy savings: | 784.5 MWh |
| Lifecycle energy savings: | 8,907 MWh |
| Capacity Savings: | 1.037 MW |
| Cost: | $263,800 |
| Participation rate: | 32% |

### Conventions

For the entire 1993 profile series all dollar values have been adjusted to 1990 U.S. dollar levels unless otherwise specified. Inflation and exchange rates were derived from the U.S. Department of Labor's Consumer Price Index and the International Monetary Fund's International Financial Statistics Yearbook: 1991.

*The Results Center* uses three conventions for presenting program savings. **Annual savings** refer to the annualized value of increments of energy and capacity installed in a given year, or what might be best described as the first full-year effect of the measures installed in a given year. **Cumulative savings** represent the savings in a given year for all measures installed to date. **Lifecycle savings** are calculated by multiplying the annual savings by the assumed average measure lifetime. **Caution:** cumulative and lifecycle savings are theoretical values that usually represent only the technical measure lifetimes and are not adjusted for attrition unless specifically stated.

# Utility Overview

Wisconsin Public Service Corporation (WPSC) is an investor-owned electric and gas utility providing service to more than 300,000 customer accounts spread over 10,000 square miles in northeastern Wisconsin and an adjacent part of Upper Michigan. WPSC owns and operates 15 hydroelectric generating sites, 3 peaking turbine or diesel plants, 3 fossil fuel plants, and one nuclear generating unit, and has 19 service centers throughout its service territory for its customers.[R#1]

Wisconsin is known for its long, cold winters and warm but short summers. The average January temperature in northern Wisconsin is 10°F, (-12°C) average July temperature is 66°F (19°C) and snowfall in the area averages 50-60 inches per year (127 - 152 cm/year) with a 140 day snow cover. Nevertheless, Wisconsin Public Service is a summer peaking utility with a record peak of 1,592 megawatts set on August 29, 1991. The previous record peak (1,516 MW) was set in the summer of 1990.[R#1]

Wisconsin Public Service Corporation's service area includes the lake port of Green Bay, the third largest city in Wisconsin, with a population of 191,900; WPSC corporate headquarters are located in Green Bay. (Green Bay is home to the Green Bay Packers and is the only remaining small Midwest city with a professional football team.) The majority of large cities in Wisconsin are outside the WPSC service area, in the southeastern part of the state. The major income producers in Wisconsin are manufacturing and processing, wholesale and retail trade, government, services, tourism, and construction.

Electricity sales accounted for 75.5% of WPSC's income in 1991 though gas operating revenues increased 9% over 1990. In 1991 WPSC had 298,194 residential accounts (which made up 89.5% of the company's total electric accounts), there were 34,106 commercial and industrial accounts (10.2%), and "other" types of accounts numbered 908 (.3%).[R#1]

**WISCONSIN PUBLIC SERVICE 1991 STATISTICS**

| | | |
|---|---|---|
| Number of Customers | 333,208 | |
| Energy Sales | 9,568 | GWh |
| Energy Sales Revenue | $451,445,140 | |
| Summer Peak Demand | 1,592 | MW |
| Generating Capacity | 1,727 | MW |
| Reserve Margin | 8.5% * | |
| **Average Electric Rates** | | |
| Residential | 6.52 | ¢/kWh |
| Commercial/Industrial | 4.48 | ¢/kWh |

[R#1]

* WPSC purchases power to maintain 12% - 15% reserve margin.

Wisconsin Public Service employed 2,619 people in 1991, an increase of 119 over the previous year. In the same year, most of the company's electricity generation was derived from coal-fired power plants (65.9%) with the remaining energy sources coming from nuclear (14.9%), hydro (3.2%), combined natural gas and fuel oil (0.4%), and power purchased from other utilities (15.6%).[R#1]

WPSC does not plan to add any baseload capacity until after 2005. WPSC is adding natural gas peaking turbines for summer peak capacity needs. Additionally, the company is negotiating several cogeneration contracts. One of these units would be fueled by up to 20% wood waste and papermill sludge. Normal reserve margins are 12% to 15%. In its energy planning, WPSC uses a least-cost planning approach and integrates facility ownership on a statewide basis.[R#6]

Wisconsin Public Service electric customers used 9,568,203 MWh in 1991, an increase of 280,289 MWh over the previous year. Gas sales rose to 313,705,000 therms in 1991, 22,772,000 therms more than the previous year. Transported gas volume also increased to 228,991,000 therms over the previous year total of 215,420,000.[R#1]

# Utility DSM Overview

Wisconsin Public Service Company began its DSM incentive program with a residential loan program in 1977. Since then, WPSC has pursued DSM through a variety of programs aimed at residential, commercial, industrial, and agricultural customers. In 1990, the company made significant changes to its DSM strategy. At that time, WPSC committed to an ambitious two-year goal of saving 155 GWh of electricity, cutting peak demand by 30 MW, and saving 9.4 million therms in gas.[R#1] These goals were met through over 35 DSM programs offered under the "Wise Buys" name to WPSC's customers. The DSM Overview Table shows energy, capacity, and gas savings achieved between 1987 and 1992. Data for DSM expenditures and data for years previous to 1987 were not available.

| **DSM Overview** | Annual Energy Savings (GWh) | Annual Summer Capacity Savings (MW) | Gross Gas Savings (million therms) |
|---|---|---|---|
| 1987 | 18.2 | N/A | N/A |
| 1988 | 24.2 | 5.00 | N/A |
| 1989 | 40.8 | 16.50 | 5.90 |
| 1990 | 63.2 | 18.70 | 6.60 |
| 1991 | 75.6 | 19.34 | 6.30 |
| 1992 | 135.0 | 38.00 | 3.90 |
| Total | 357.0 | 97.54 | 22.70 |

[R#4,6] (1987-1990 figures are gross; 1991-1992 figures are net)

WPSC's Wise Buys programs offer financial incentives, low interest financing, load control, and shared savings opportunities to residential, commercial, industrial, and agricultural customers. In WPSC's 1993 DSM plan, the company outlines its short and long-term DSM goals and strategies. For commercial and industrial programs, the company plans to strengthen its relationship with trade allies by offering marketing tools and training scholarships. Additionally, WPSC is working with several campuses of the University of Wisconsin system to begin

**WISCONSIN PUBLIC SERVICE DSM PROGRAMS**

**Residential**

- Residential Lighting
- Wise Buys Appliance Turn-In
- Home Energy Checkup
- New Construction
- Gas/Electric Conservation Packaging
- Conservation Finance Plan
- Wise Buys Appliance Rebates
- Optional Time-of-Use Pricing
- Wise Buys Energy Fitness
- Direct Load Control
- Hot Water Savings

**Agricultural**

- **Rebates (includes Irrigation Program)**
- Time of Use Pricing
- Guaranteed Savings
- Farm Energy Evaluation
- Stray Voltage Assistance
- Special Research Projects

**Commercial / Industrial**

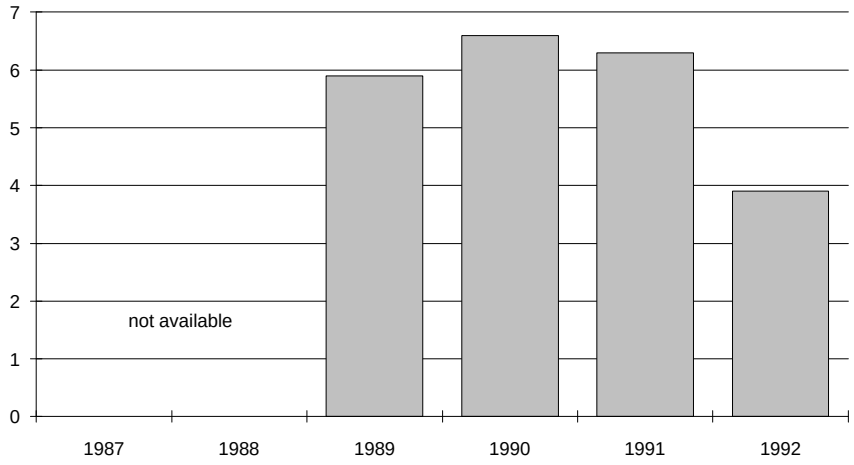
- Wise Buys Electric and Natural Gas Rebates
- Natural Gas Water Heating Conversion
- Trade Ally Lighting Retrofit Program
- Finance Program
- Design Studies
- Load Management

**Other**

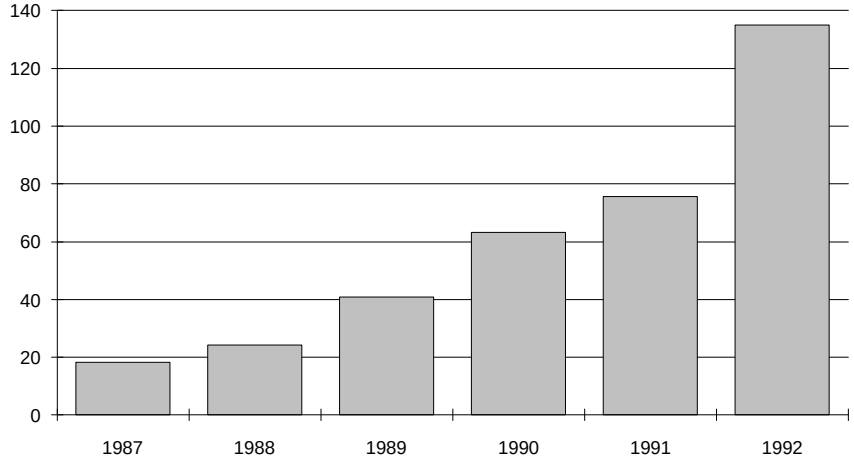
- Custom Rebates for Solar Water Heating & Other Renewable Energy Projects
- Weatherization Assistance Program
- For Landlords Only Program
- Community Conservation Project

[R#2,3,4 ]

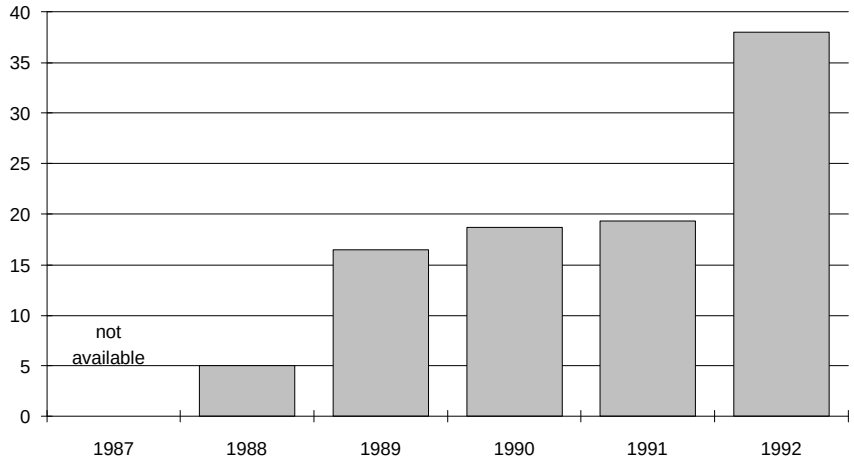
**GROSS GAS SAVINGS (MILLIONS THERMS)**




**ANNUAL ENERGY SAVINGS (GWH)**




**ANNUAL CAPACITY SAVINGS (MW)**



energy efficiency initiatives. In 1993, WPSC will be investigating innovative energy-efficiency technologies for commercial and industrial customers, including solar domestic water heating, solar powered pasture pumping for livestock watering, natural gas air conditioning, low-temperature dishwashers, and photovoltaic applications. [R#4]

The DSM program for agricultural customers includes rebates for installation of a variety of energy-efficient equipment. The highly successful Irrigation Program, the subject of this profile, was principally responsible for the overall success of WPSC's agricultural programs in meeting their 1991 demand savings goals. [R#4]

WPSC is initiating a community conservation project along the lines of Espanola, Hood River, and Rock Valley (see The Results Center Profiles #16, #12, and #43). The Community Conservation Pilot will be conducted in the town of Merrill, located about 100 miles northwest of Green Bay. One of the principal goals of the project will be to determine the effect of community involvement on participation rates, program savings, and cost-effectiveness of DSM programs. In Merrill, the community will be actively involved in both the design and implementation of the DSM programs.

WPSC also has a low-income weatherization program, which pays 100% or 75% of the cost of eligible measures in owner-occupied and rental properties, respectively. The For Landlords Only program is aimed at encouraging implementation of energy-efficiency measures in rental properties.

WPSC's Irrigation Program offers rebates for agricultural customers who install reduced pressure irrigation systems. Reduced pressure systems typically operate at 50 to 65 pounds per square inch (psi) or 345 - 448 kilopascals (kPa) with 60 to 75 horsepower motors to deliver 1,000 gallons per minute, (3,785 litres per minute) whereas conventional systems operate at about 100 psi (689 kPa) with 100 horsepower motors to deliver the same volume of water. Reduced pressure systems work by changing the location and size of the sprinkler nozzles that distribute water to the crop. Thus, in order to achieve the necessary water application rate (in inches of water per unit of land area), less pressure is required. (A typical low pressure system delivering 1,000 gallons per minute would require less than 50 psi (345 kPa) and operate with a motor of 50 horsepower or less. See The Results Center Profile #40 for a glossary of irrigation terms.)

The program provides incentives for irrigation system components, including new motors, based on estimated demand reduction. Pump tests, vital to the proper design of a reduced pressure irrigation system, are required prior to any other changes to ensure that the system will have adequate capacity to support a reduced pressure system. The pump tests also establish a baseline for the system operation and insure the appropriateness of the technology for specific applications prior to any investment by the farmer. Rebates of up to $300 will generally cover 100% of the cost of a required pump test.

The program was first planned in the winter of 1988 as one component of several offered to WPSC's agricultural customers. While it was first implemented in the growing season of 1989 the program really began to take off in 1991. Initially the program ran into some resistance by farmers to the new technology. Reduced pressure systems were confused with low pressure systems, which had gained a poor reputation among the Wisconsin potato farmers who make up the majority of the center-pivot irrigators in WPSC's service territory. With the types of nozzles currently available, low pressure systems are usually not appropriate for the types of soils and crops found in Wisconsin. In low pressure systems, each sprinkler nozzle distributes a very narrow band of water to the soil surface, and the application rate (in inches of water per unit time) is so much higher than a conventional system, that erosion of the mounds around the potato plants tends to occur. Additionally, low pressure systems had been installed in some applications where pressure drops on hilly terrain resulted in uneven water application. As a result, farmers who had retrofitted with low pressure irrigation systems were not satisfied with the results.

Another issue for growers in WPSC's service territory is that some produce buyers impose stringent rules regarding irrigation. Before making a purchase, many buyers require proof that the crop has received specified amounts of water during different periods of its growth cycle, thus ensuring an adequate moisture content. As a result of these rules, some farmers are unable to change their irrigation practices.

In order to promote the reduced pressure irrigation systems, WPSC needed to first overcome the misconceptions that farmers had about their operation and applicability. Early on, WPSC recognized the value of working with trade allies and the University of Wisconsin Cooperative Extension Service in introducing the energy-efficiency technologies promoted by the Irrigation Program, and the other components of WPSC's DSM program for agricultural customers. WPSC realized that the

| Irrigation System Types | Flow Rate (gallons per minute) | Pressure Range (psi) | Motor Horsepower Required | End Sprinkler Diameter (feet) | Average Application Rate (inches of water per hour) | Time to Cover Width of Sprinkler Diameter (minutes) |
|---|---|---|---|---|---|---|
| High Pressure | 1,000 | > 100 | > 100 | 175 | 0.7 | 42 |
| Reduced Pressure | 1,000 | 55 - 65 | 60 - 75 | 70 | 1.8 | 17 |
| Low Pressure | 1,000 | < 50 | < 50 | 45 | 2.8 | 10.3 |

Average Application Rate (AAR) is calculated for 1,300 foot system at 7.0 gallons per minute per acre as follows:
AAR = (gpm/acre x radius of system) / (72.217 x end sprinkler diameter)

Figures are calculated based on the following Nelson pivot sprinkler packages:
high: impact sprinklers 20,33,70's; reduced: rotators R30-U4; low: spinners S30-D6.

Time to Cover Width of Sprinkler Diameter is calculated assuming 910 gpm flow rate.

[R#7,8]

equipment dealers and Cooperative Extension agents had developed a trusting relationship with farmers which could provide a natural interface for the utility. Now the Irrigation Program, and in fact, all of the utility's agricultural DSM programs, are implemented with the direct assistance of trade allies and Cooperative Extension agents. It is this partnership that is responsible for the changing attitudes toward reduced pressure irrigation systems in Wisconsin.

With each installed system, the program began to catch on. Larger growers with several irrigation systems obviously did not want to retrofit their entire operation until they were certain of the viability and potential savings of a new system. Farmers were wary of installing systems in heavy soils, where the wheels of the irrigation equipment were likely to get stuck if the soils became highly saturated; however the reduced pressure systems performed well even in those potentially adverse conditions. As more systems were installed and results became known among the agricultural community, the program began to sell itself. Now, not only are the trade allies, extension agents, and utility personnel advocating the program, but satisfied growers are promoting the installation of reduced pressure irrigation systems as well.

Trade allies and Cooperative Extension are able to assess the applicability of a new reduced pressure irrigation system for each potential customer. Here, it is especially important that the farmer trusts the equipment dealer's judgment regarding the potential investment. If the farmer does not respect the trade ally's assessment, then the technology cannot be properly promoted.

Reduced pressure irrigation systems are appropriate for approximately 50% of WPSC's agricultural customers who have irrigation systems. The Irrigation Program has been highly successful at achieving demand savings on these farms, however WPSC recognizes that it may still need to generate further demand savings, even after all appropriate applications of reduced pressure irrigation have been pursued. To that end, WPSC plans to introduce direct load control in the agricultural sector, as part of the Irrigation Program. Direct load control will generate extremely small energy and capacity savings, however it does offer opportunities to clip peak demand significantly. Additionally, WPSC has helped to fund the development of better scheduling and weather data systems whose use is expected to reduce overall energy demand and use by irrigators.

## MARKETING

The Irrigation Program is primarily marketed through WPSC's trade allies and the University of Wisconsin Cooperative Extension Service. (Note that WPSC is comparatively quite short-staffed in terms of customer representatives for its agricultural customers. It has one agricultural service representative for every 3,000 agricultural customers, compared to a ratio of about one to 1,000 for commercial and industrial customers.)

- WPSC relies heavily on trade allies to promote its DSM programs for agricultural customers. There are many equipment dealers in the WPSC service territory who are aware of the rebates available through WPSC and who actively promote their use. Four of these trade allies form the core of the promotion effort, as they have high customer contact and actively promote the program.[R#6]

- The University of Wisconsin Cooperative Extension Service sponsors frequent workshops and seminars on irrigation techniques and energy-efficiency in agricultural applications. Through these workshops, farmers may be introduced to new technologies and to the incentives available to them through WPSC's program. WPSC supports Cooperative Extension work through no-strings-attached grants. That is, by accepting financial support from the utility, Cooperative Extension has no obligation to promote WPSC's programs, and can thus maintain the neutrality which has been vital in the development of a trusting relationship with Wisconsin's agricultural community.[R#6]

- WPSC also uses direct mail, some limited advertising in trade publications, local radio and newspaper advertising, to inform customers of their eligibility under the program. Additionally, WPSC publishes a customer newsletter, *"The Farm Connection."*

## DELIVERY

The Irrigation Program is implemented with the direct assistance of the trade allies. Participation in the program is usually initiated when customers express an interest in the program to the trade ally, or the trade ally identifies an eligible customer in the course of routine transaction.

The trade ally, an equipment dealer, performs a pump test to determine the baseline volumes, pressures, and well water levels during pumping. The pump test is an important first step in the design of a reduced pressure system. Pump test results are used to determine the most appropriate pump and motor sizes necessary for proper operation of a reduced pressure system.[R#8] The pump test also serves to provide a basis for ensuring that the volume of water delivered by the existing system is comparable to that delivered after the new system is put into place.[R#7] The pump test is eligible for a rebate of up to $300 to cover the cost of the test. At the time of the pump test, the trade ally also has the opportunity to survey the land on which the system would be used, and determine the suitability of the terrain. The cost of the test is reimbursed even if the system is not installed.

Together, the trade ally and customer determine if the application is appropriate. Then the customer may go ahead with purchase and installation of the irrigation system. A typical irrigation system retrofit entails purchase and installation of new sprinkler nozzles, a new downsized motor for the pump, and rebuilding the pump. Usually, everything needed for the retrofit of a sprinkler

system is sold as a package, and installation is usually completed by the equipment dealer or by the farmer. After the system is installed, the customer submits the pump test certification card and equipment invoices to WPSC. WPSC staff conduct a post-installation inspection, assist the customer with completion of the rebate application forms, approve the incentive payment, and issue a rebate check either payable to the customer or, in the event that the invoice is not marked paid, payable to both the trade ally and the customer. The rebate process takes about two or three weeks from the time the completed application is received by WPSC.[R#7]

**WPSC IRRIGATION PROGRAM**
**1992 REBATE AMOUNTS**

| | |
|---|---|
| Reduced pressure irrigation system | $200/kW & 2¢/first year kWh saved |
| Well pump test | up to $300 |
| High-efficiency pump motors | $10/kW |
| Tower drive motors | $10/kW |
| End-gun booster pump | $10/kW |

## MEASURES INSTALLED

Through the Irrigation Program, well pump tests are performed, and irrigation systems are retrofitted to accommodate reduced pressure systems. Pumps and pump motor retrofits necessary for the proper operation of the reduced pressure irrigation systems are also eligible for rebates under the program. Installation of new systems may qualify for rebates under the program if there is a kW reduction. Rebates are calculated on a per kW-reduced basis, and irrigation systems are also eligible for 2 ¢ per first-year kWh saved, as shown in the Rebate Amount Table. (Five hundred hours of annual usage is typical.)

## STAFFING REQUIREMENTS

The Irrigation Program is implemented as part of WPSC's Wise Buys for the Farm energy-efficiency program. The program administrator works out of WPSC's corporate office. WPSC has four rural marketing consultants who serve its agricultural customers from the utility's regional offices, implementing all of WPSC's agricultural programs and services. A total of about 0.5 Full Time Equivalents (FTEs) are necessary for the implementation of the Irrigation Program. Naturally, these staff dedicate a greater amount of their time to the Irrigation Program before the growing season begins and at the end of the growing season in the Fall, when customers are most likely to be making changes to their irrigation systems, than at other times of the year. Additionally, the actual annual staffing requirement varies depending on the amount of program activity.[R#6,7,8]

There are several equipment dealers involved with the Irrigation Program, but most of the program activity is implemented by four Wisconsin equipment dealers. These trade allies perform pump tests, actively promote reduced pressure irrigation systems and qualifying pumps and pump motors to appropriate customers, and often perform system installations. Additionally, trade allies act as a liaison between the customer and WPSC.

## MONITORING

The pump test serves as an initial monitoring opportunity. During the pump test, the baseline conditions of the existing irrigation system and its operation are recorded, and this information is used to verify energy and demand savings. Installations are confirmed through a post-installation inspection by WPSC personnel.

All data regarding customer rebate applications are entered into a database. Internal monthly monitoring reports are generated from the database.

WPSC is performing some end-use monitoring in conjunction with Wisconsin Power and Light. The results of these tests will serve to verify and fine-tune actual coincident peak demand and the amount of reductions attributable to the reduced pressure irrigation systems. The monitoring program will continue through the 1993 season. Results from 1992 were not typical, as 1992 was one of the coolest years on record, and irrigation requirements were unusually low.[R#6]

## EVALUATION

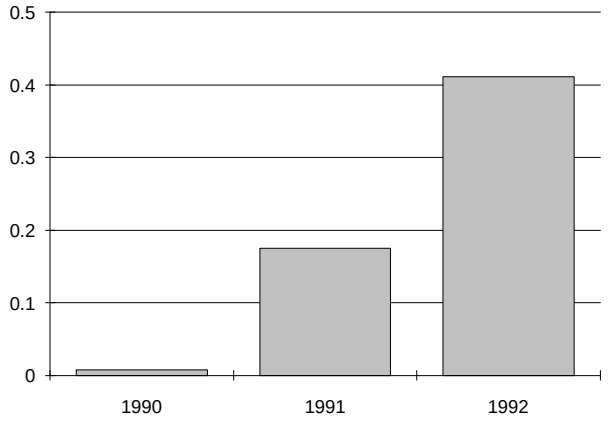
WPSC has not conducted any formal evaluations of the Irrigation Program. A baseline evaluation for the load management program is planned for 1993. This evaluation will be used to establish a basis for comparison of irrigators' attitudes and operating procedures before and after implementation of the load management plan.

One study of 29 trade allies, completed in 1991, provided new direction for the agricultural sector DSM programs at WPSC. The evaluation revealed that dealers have varying degrees of expertise relating to the agricultural equipment which they promote and install in conjunction with WPSC's agricultural programs. As a result, WPSC plans to increase the amount of personal contact with trade allies, develop newsletters aimed at dealers, and provide enhanced marketing materials for dealer use.[R#4]

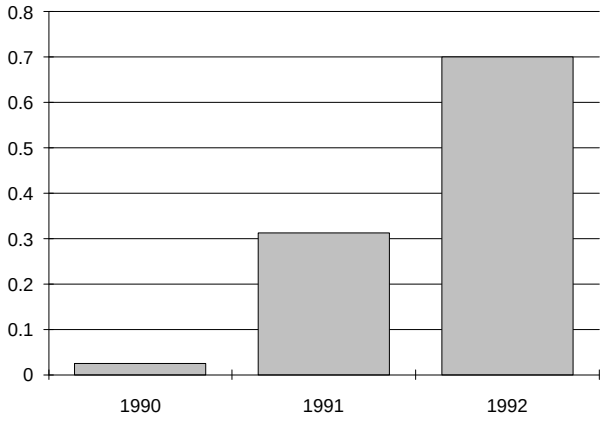
# Program Savings

| **Savings Overview Table** | Annual Energy Savings (MWh) | Cumulative Energy Savings (MWh) | Lifecycle Energy Savings (MWh) | Annual Capacity Savings (MW) | Cumulative Capacity Savings (MW) |
|---|---|---|---|---|---|
| 1990 | 8.0 | 8.0 | 120.1 | 0.025 | 0.025 |
| 1991 | 174.8 | 182.8 | 2,621.3 | 0.312 | 0.337 |
| 1992 | 411.0 | 593.8 | 6,165.3 | 0.700 | 1.037 |
| Total | 593.8 | 784.5 | 8,906.6 | 1.037 | |

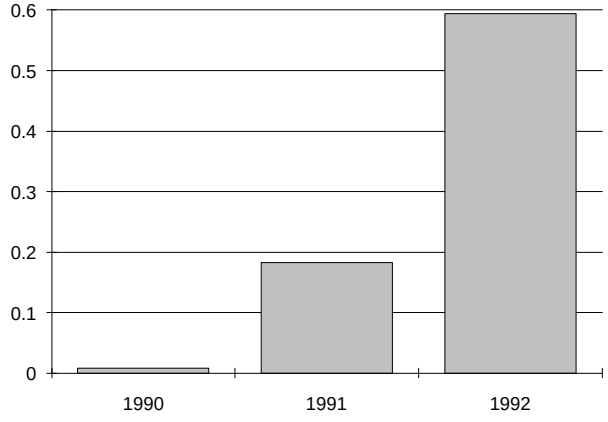
**ANNUAL ENERGY SAVINGS (GWH)**



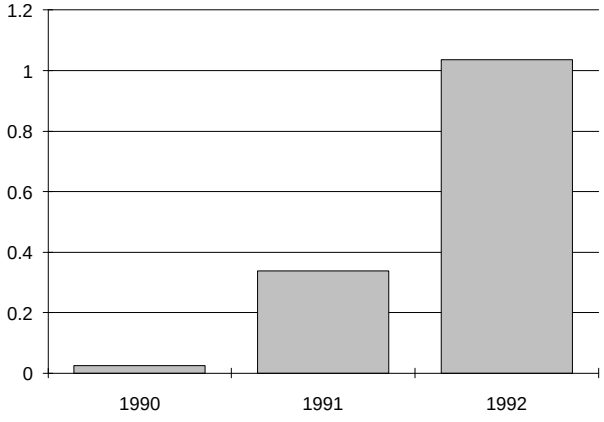

**ANNUAL CAPACITY SAVINGS (MW)**




**CUMULATIVE ENERGY SAVINGS (GWH)**




**CUMULATIVE CAPACITY SAVINGS (MW)**



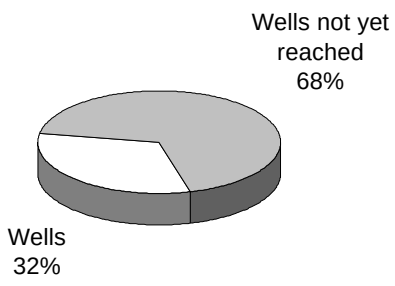
In 1992, the Irrigation Program resulted in energy savings of 411 MWh and lifecycle savings of 6,165 MWh. Capacity savings in 1992 were 700 kW. The program had few savings during its early pilot years, and significant savings did not begin to accumulate until 1991. Between 1990 and 1992, annual energy savings totaled 594 MWh, and capacity savings were 1.037 MW.

## PARTICIPATION RATES

Thirty-nine reduced pressure irrigation systems were installed on 31 different wells between 1990 and 1992. (Note that some wells serve more than one center-pivot system.) WPSC estimates that about one-half of the 385

| Participation Table | Energy Efficient Irrigation Systems Installed | Number of Wells | Annual Energy Savings per Well (kWh) |
|---|---|---|---|
| 1990 | 1 | 1 | 8,004 |
| 1991 | 9 | 9 | 19,417 |
| 1992 | 29 | 21 | 19,572 |
| Total | 39 | 31 | |

wells eligible to participate in the program have terrain and well volumes suitable for reduced pressure irrigation systems. Of these, another half have barriers to implementation such as inappropriate crop type(s), or stringent buyers' rules regarding crop irrigation.[R#6] Thus, there are approximately 96 wells being targeted by the Irrigation Program, and about one-third have already been reached.




## FREE RIDERSHIP

WPSC uses a free-ridership factor of 20% in its calculations of savings for the Irrigation Program. When the program was first introduced, free-ridership was not an issue, as very few farmers were interested in improving the efficiency of their irrigation systems. As the program grew, the benefits of reduced pressure irrigation were demonstrated, and the fears of farmers regarding the new systems were allayed. Thus, as a result of the program more growers are now interested in installing these systems than there would have been in its absence. With this successful market transformation WPSC is considering reducing the rebate levels for 1994.

The savings data presented in the Savings Overview Table have been derated for free-ridership.

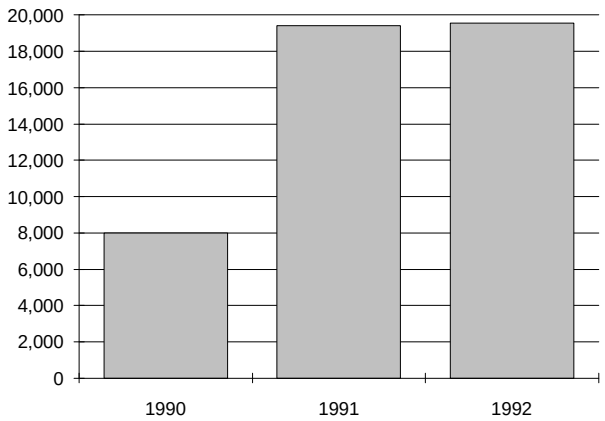
## MEASURE LIFETIME

An average lifetime of 15 years is used by WPSC in its calculations for the Irrigation Program. The Results Center used 15 years in calculating lifecycle savings in the Savings Overview Table and the cost of saved energy in the Cost of the Program section of this profile.

## PROJECTED SAVINGS

WPSC projects that the Irrigation Program will have reached its target market within two or three years. In 1993, WPSC hopes to install 20 new reduced pressure systems for total savings of 320 MWh and 360 kW. As the Irrigation Program has met or exceeded its energy and demand savings goals in 1991 and 1992, it is realistic to expect that the program will also meet 1993 savings goals.

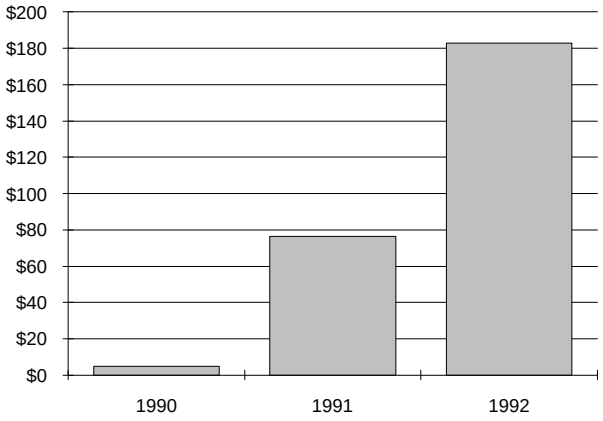
**ANNUAL ENERGY SAVINGS PER WELL (KWH)**



# Cost of the Program

| Costs Overview Table | Rebates for Irrigation Equipment (x1000) | Rebates for Pump Tests (x1000) | Administration and Implementation Cost (x1000) | Total Program Cost (x1000) | Utility Cost per Well |
|---|---|---|---|---|---|
| 1990 | $2.8 | not available | $2.0 | $4.8 | $4,775 |
| 1991 | $66.7 | not available | $9.6 | $76.2 | $8,471 |
| 1992 | $166.3 | $7.2 | $9.3 | $182.8 | $8,706 |
| Total | $235.8 | $7.2 | $20.9 | $263.8 | |

**TOTAL PROGRAM COST (x1,000)**




**COST PER WELL**


| Cost of Saved Energy Table (¢/kWh) | Discount Rates | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3% | 4% | 5% | 6% | 7% | 8% | 9% |
| 1990 | 5.00 | 5.37 | 5.75 | 6.14 | 6.55 | 6.97 | 7.40 |
| 1991 | 3.65 | 3.92 | 4.20 | 4.49 | 4.79 | 5.10 | 5.41 |
| 1992 | 3.73 | 4.00 | 4.29 | 4.58 | 4.88 | 5.20 | 5.52 |

In 1992, the Irrigation Program cost $182,800, more than double the program's 1991 expenditure of $76,200. Expenditures over the three years 1990 to 1992 total $263,800, which includes an estimated $10,000 in promotional and administrative costs in 1991 and 1992, and $2,000 for 1990.

## COST EFFECTIVENESS

WPSC has performed benefit-cost tests on the Irrigation Program, with virtually all results indicating that the program is cost effective. The benefit-cost ratios determined using the Participants Test, the Total Resource Cost Test, and the Societal Test were 5.23, 5.34, and 5.34, respectively. The Utility Test produced a benefit-cost ratio of 1.86, and the Rate Impact Test ratio was 0.90. Using the Total Resource Cost test, WPSC determined the levelized program life cycle costs to be 3.14 ¢/kWh.[R#6]

The Results Center calculated the cost of saved energy for the program as shown in the Cost of Saved Energy Table. In 1992, the Irrigation Program cost between 3.73 and 5.52 ¢/kWh, depending on the discount rate used. The Results Center calculated the cost per kW reduced at $261/kW in 1992, $244/kW in 1991, and $192/kW in 1990.

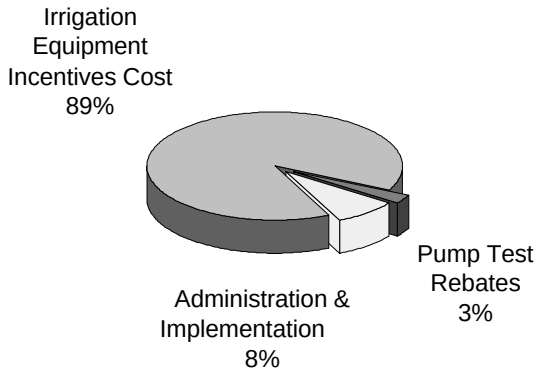
## COST PER PARTICIPANT

The Results Center calculated the utility's total average cost per participant, including administrative and implementation costs, for 21 wells in 1992 at $8,700 per well. The total utility cost per system installed, with 29 in 1992 was about $6,300.

A typical retrofit costs $8,000 to $10,000, and WPSC rebates can cover anywhere from 20% to 100% of the cost, depending on the characteristics of the existing system and the retrofit. In 1992, total installation costs (including pump tests) for the 29 systems installed were $504,000 WPSC covered $173,500 of those costs, so customer contributions totaled $330,500. Thus, the Irrigation Program covered about 32% of the total installation costs (including pump tests) in 1992.[R#9] For 1991, the total installation cost for systems installed was $119,440 and WPSC paid $66,700 in rebates, to cover an average of 56% of the total retrofit costs.[R#10]

## COST COMPONENTS

Aside from incentive payments, WPSC has very few costs associated with the Irrigation Program. Staff are shared among other agricultural programs and promotion is done primarily through the trade allies. As a result, the only costs incurred for promotional activities are for printing and distribution of the program brochures, a cost that WPSC estimates amounts to be about $1,000 annually. WPSC estimates administrative, planning, implementation, evaluation, and promotional costs for the rebate portion of the Irrigation Program at about $10,000 annually.[R#6] Non-incentive costs during 1990 were likely to be less than in 1991 and 1992, as there was significantly less program activity in 1990; 1990 administrative and implementation costs were estimated at $2,000. Thus all non-incentive costs of the program total about 8% of the total program costs. Incentive payments for irrigation equipment represent about 89% of the total program costs and rebates for pump tests account for the remaining 3%.



# Environmental Benefit Statement

| Marginal Power Plant | Heat Rate BTU/kWh | % Sulfur in Fuel | CO2 (lbs) | SO2 (lbs) | NOx (lbs) | TSP* (lbs) |
|---|---|---|---|---|---|---|
| **Coal** | **Uncontrolled Emissions** | | | | | |
| A | 9,400 | 2.50% | 1,691,000 | 40,000 | 8,000 | 1,000 |
| B | 10,000 | 1.20% | 1,804,000 | 16,000 | 5,000 | 4,000 |
| | **Controlled Emissions** | | | | | |
| A | 9,400 | 2.50% | 1,691,000 | 4,000 | 8,000 | 0 |
| B | 10,000 | 1.20% | 1,804,000 | 2,000 | 5,000 | 0 |
| C | 10,000 | | 1,804,000 | 10,000 | 5,000 | 0 |
| | **Atmospheric Fluidized Bed Combustion** | | | | | |
| A | 10,000 | 1.10% | 1,804,000 | 5,000 | 3,000 | 1,000 |
| B | 9,400 | 2.50% | 1,691,000 | 4,000 | 3,000 | 0 |
| | **Integrated Gasification Combined Cycle** | | | | | |
| A | 10,000 | 0.45% | 1,804,000 | 3,000 | 1,000 | 1,000 |
| B | 9,010 | | 1,622,000 | 1,000 | 0 | 0 |
| **Gas** | **Steam** | | | | | |
| A | 10,400 | | 984,000 | 0 | 2,000 | 0 |
| B | 9,224 | | 854,000 | 0 | 5,000 | 0 |
| | **Combined Cycle** | | | | | |
| 1. Existing | 9,000 | | 854,000 | 0 | 3,000 | 0 |
| 2. NSPS* | 9,000 | | 854,000 | 0 | 2,000 | 0 |
| 3. BACT* | 9,000 | | 854,000 | 0 | 0 | 0 |
| **Oil** | **Steam--#6 Oil** | | | | | |
| A | 9,840 | 2.00% | 1,424,000 | 22,000 | 3,000 | 2,000 |
| B | 10,400 | 2.20% | 1,510,000 | 21,000 | 3,000 | 2,000 |
| C | 10,400 | 1.00% | 1,510,000 | 3,000 | 3,000 | 1,000 |
| D | 10,400 | 0.50% | 1,510,000 | 9,000 | 3,000 | 0 |
| | **Combustion Turbine** | | | | | |
| #2 Diesel | 13,600 | 0.30% | 1,890,000 | 4,000 | 6,000 | 0 |
| **Refuse Derived Fuel** | | | | | | |
| Conventional | 15,000 | 0.20% | 2,244,000 | 6,000 | 8,000 | 2,000 |

**Avoided Emissions Based on 784,537 kWh Saved (1990 - 1992)**

In addition to the traditional costs and benefits there are several hidden environmental costs of electricity use that are incurred when one considers the whole system of electrical generation from the mine-mouth to the wall outlet. These costs, which to date have been considered externalities, are real and have profound long term effects and are borne by society as a whole. Some environmental costs are beginning to be factored into utility resource planning. Because energy efficiency programs present the opportunity for utilities to avoid environmental damages, environmental considerations can be considered a benefit in addition to the direct dollar savings to customers from reduced electricity use.

The environmental benefits of energy efficiency programs can include avoided pollution of the air, the land, and the water. Because of immediate concerns about urban air quality, acid deposition, and global warming, the first step in calculating the environmental benefit of a particular DSM program focuses on avoided air pollution. Within this domain we have limited our presentation to the emission of carbon dioxide, sulfur dioxide, nitrous oxides, and particulates. (Dollar values for environmental benefits are not presented given the variety of values currently being used in various states.)

## HOW TO USE THE TABLE

1. The purpose of the previous page is to allow any user of this profile to apply Wisconsin Public Service Corporation's level of avoided emissions saved through its Wise Buys lrrigation Program to a particular situation. Simply move down the left-hand column to your marginal power plant type, and then read across the page to determine the values for avoided emissions that you will accrue should you implement this DSM program. Note that several generic power plants (labelled A, B, C,...) are presented which reflect differences in heat rate and fuel sulfur content.

2. All of the values for avoided emissions presented in both tables include a 10% credit for DSM savings to reflect the avoided transmission and distribution losses associated with supply-side resources.

3. Various forms of power generation create specific pollutants. Coal-fired generation, for example, creates bottom ash (a solid waste issue) and methane, while garbage-burning plants release toxic airborne emissions including dioxin and furans and solid wastes which contain an array of heavy metals. We recommend that when calculating the environmental benefit for a particular program that credit is taken for the air pollutants listed below, plus air pollutants unique to a form of marginal generation, plus key land and water pollutants for a particular form of marginal power generation.

4. All the values presented represent approximations and were drawn largely from "The Environmental Costs of Electricity" (Ottinger et al, Oceana Publications, 1990). The coefficients used in the formulas that determine the values in the tables presented are drawn from a variety of government and independent sources.

*** Acronyms used in the table**

TSP = Total Suspended Particulates
NSPS = New Source Performance Standards
BACT = Best Available Control Technology

## LESSONS LEARNED

The Irrigation Program has been highly successful thanks in large part to WPSC's recognition of the value of a positive relationship with its trade allies. Resistance to unfamiliar technologies may be especially prevalent among agricultural customers. The utility must first overcome any preconceived notions about energy-efficiency techniques before any change can be implemented. Irrigation practices in particular are deeply ingrained, and farmers have typically been reluctant to risk their crop and livelihood by installing an unfamiliar system. By introducing reduced pressure irrigation systems to eligible farmers through dealers and cooperative extension, WPSC took advantage of the longstanding trusting relationship that the dealers and cooperative extension agents have with farmers. This strategy has been successfully applied to all of WPSC's agricultural DSM programs.

Implementing the Irrigation Program through trade allies has had other significant benefits. WPSC's administrative costs are minimal. The utility has done only limited direct mailings and no telemarketing in order to inform customers of their eligibility. The trade allies and extension agents are able to identify eligible customers and promote the program directly. It is likely, however, that as the irrigation program nears 100% penetration of its target market, WPSC will need to take a more active role in promoting the program to any remaining non-participants. Although the rebate levels for 1994 may decrease due to the successful transformation of the market for reduced pressure systems, WPSC's primary objective with the Irrigation Program is to get as many reduced pressure systems installed as possible before the direct load control program is implemented.

Unlike some other reduced pressure irrigation programs, WPSC requires that motors be changed out to lower horsepower motors to qualify for incentives. While reduced pressure irrigation would still work if the pump was merely throttled back, this practice does little to reduce peak demand when the pump is turned on. Nor does this practice take full advantage of potential savings, as only about 60% to 70% of total possible savings are realized using this technique. WPSC has met optimistic demand reduction goals for the irrigation program thanks to this program requirement. Additionally, although reduced pressure irrigation can be accomplished simply by reducing amperage of a motor, WPSC's requirement prevents the possibility that the farmer will later increase amperage, and thus eliminate any energy savings.[R#8]

The trade allies have benefited from their participation in the program. The rebates available through the Irrigation Program boost sales by encouraging customers to make purchases of equipment that might otherwise be unaffordable. In fact, the rebate levels in WPSC's Irrigation Program were designed in cooperation with the trade allies specifically to cover the average cost of retrofitting a conventional sprinkler irrigation system with a reduced pressure system. In this way, there is minimal cost to the farmers who are typically reluctant to put forth any expenditure on a new irrigation system.

## TRANSFERABILITY

Several unique aspects of WPSC's Irrigation Program are highly transferable. In most areas, utilities can expect to find similar relationships among cooperative extension, equipment dealers, and farmers, as the ones that exist in WPSC's service territory. Utilities can take advantage of these alliances to help promote their agricultural DSM programs to the mutual benefit of all parties.

Of course reduced pressure systems may not be optimal for all applications. In fact in Colorado the Western Area Power Administration promotes Low Energy Precision Application systems, a type of low pressure irrigation system. (See The Results Center Profile #40.) Low pressure systems provide further savings over reduced pressure irrigation and are thus ideal if such a system is appropriate for the crop types, soils, and terrain.

In other countries, utilities and agencies implementing a similar program might want to carefully examine the role of cooperative extensions in promoting efficient agricultural practices. Note that WPSC can focus its program on installation of equipment as a complementary program to the extension service's programs. For instance, cooperative extension services promote irrigation scheduling techniques as a means of saving energy and water, alleviating the utility's need to include this service in its agricultural DSM programs. WPSC has partially funded the development of a computerized scheduling system that would optimize water usage based on soil moisture and weather forecasting. Use of such a system will result in reduced energy consumption and peak demand reductions, as irrigation during peak periods will be decreased and irrigation efficiency will be enhanced.[R#6]

Traditional utility ratemaking, where each and every kilowatt-hour sold provides profit, is a major barrier to utilities' implementation of energy efficiency programs. Several state regulatory commissions and their investor-owned utilities have been pioneers in reforming ratemaking to a) remove the disincentives in utility investment in DSM programs, and b) to provide direct and pronounced incentives so that every marginal dollar spent on DSM provides a more attractive return than the same dollar spent on supply-side resources.

The purpose of this section is to briefly present exciting and innovative incentive ratemaking mechanisms where they're applied. This we trust, will not only provide some understanding to the reader of the context within which the DSM program profiled herein is implemented, but the series of these sections will give useful snapshots of incentive mechanisms being used and tested across the United States.

## HISTORY OF IRP IN WISCONSIN

Wisconsin's procedures for rate review, use of future test year in annual rate cases, and accounting for DSM expenditures have removed many of the financial disincentives to DSM. The Wisconsin Public Service Commission has considered and tested a variety of shareholder incentives mechanisms with the four major utilities in the state since 1987, however no shareholder incentive mechanisms are active in the state at this time. (Readers can refer to the incentive sections of Profiles #24 and #32 for provisions directly related to Wisconsin Electric.)[R#13]

State power plant siting law requires utilities to file Advance Plans approximately every two or three years which must include analyses of alternative resources. The Integrated Resource Planning process is implemented in Wisconsin through these plans. In 1986 the Commission ordered utilities in the state to use a least-cost integrated planning process in which all reasonable options for both supply and demand are assessed, including long term social and environmental costs. An environmental externalities adjustment, or "noncombustion credit", of 15% is applied to selected nonfossil fuel resources and was instituted in 1989. This was replaced with explicit cost adders for greenhouse gases in 1992.[R#13]

## DSM COST RECOVERY

Utilities in Wisconsin have been able to recover DSM expenditures either as expenses or as capitalized expenditures through a conservation escrow account. The order on the escrow account goes back to 1977; the rate-basing treatment provision was the result of an order passed in 1986. The conservation escrow account, like a balancing account mechanism, allows the utility to collect DSM expenditures, dollar for dollar, reconciling actual with recovered expenditures.[R#13]

In 1989, the Commission staff asked the utilities to consider an Electric Revenue Adjustment Mechanism (ERAM) as a means of removing the lost revenue disincentive from demand-side management. The utilities rejected ERAM for Wisconsin because of its short term perspective and potential effects on large customers. Thus no ERAM has been instituted in Wisconsin.[R#13,14]

## DSM INCENTIVES AT WISCONSIN PUBLIC SERVICE CORPORATION

In 1990, nearly four years after a similar order for Wisconsin Electric, the Commission ordered WPSC to scale up its investment in conservation activities beginning in 1991. While costs could be ratebased, WPSC was not and is not entitled to lost revenue adjustments or shareholder incentives.[R#12]

Prior to the 1990 order, WPSC had designed a regulatory incentive mechanism that would provide the utility an incentive based on the annual number of kWh saved by its conservation programs. The per kWh bonus was to be awarded for savings above a predetermined threshold and would rise once a second threshold level of savings was achieved. If savings fell below the first threshold, a per kWh penalty was to be assessed.[R#12]

No attempt was made by either the utility or the commission to implement this mechanism. In fact, the utility believed that it would cost more in terms of staff time to file for incentives than the level of incentive that might be awarded! Thus the mechanism was never adopted, no incentives or penalties were paid. No formal action has been taken to discontinue this mechanism, but it is not currently active.[R#12]

## FUTURE DIRECTIONS IN WISCONSIN

According to the Wisconsin Public Service Commission staff, what's happening in Wisconsin may not suit other states at all but certainly presents an interesting case study. Wisconsin has dropped stockholder incentives at least for the time being not for a lack of effort or DSM activity. Wisconsin remains one of the most aggressive DSM states in terms of the percentage of gross revenues spent on DSM. The individual utilities and the Commission are still looking for a mechanism to encourage DSM efforts and agree upon a level of measurement that is acceptable to both utilities and interveners.[R#14]

In the current Advance Plan 6 order, the Commission expressed that it is still interested in stockholder incentive mechanisms and said it will certainly consider any proposed mechanisms. In anticipation of utility proposals, the Commission presented a set of criteria, or guidelines, that utilities must meet to be eligible for the incentives. [R#14]

Incentives are also being considered for renewable energy developments, but that's in large part due to the fact that the state's utilities have declining amounts of renewables in their Advance Plans. Renewables, unlike DSM, can be metered, and thus the issue of verification is much more straight forward.[R#14]

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