# Northern States Power

## High Efficiency Motors & Drives

### Profile #65


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# Executive Summary

To the credit of Northern States Power and its focus on the promotion of energy-efficient motors and drives, the utility has recently been invited to Washington, D.C. to attend the signing of a new U.S. Department of Energy, Environmental Protection Agency, industry, and utility compact called the "Motors Challenge." Four utilities have been invited to attend the signing and to participate in the kick-off of this new public/private sector partnership to promote the efficient use of energy in drivepower systems.

Northern States Power has been offering its commercial and industrial customers energy-efficient motor rebates since 1986 and expanded its program to encompass rebates for energy-efficient adjustable speed drives in 1992. At the same time, it increased its rebates for motors to ramp up participation and boost energy savings.

One of the features of NSP's program is that it provides its customers with a two-tiered rebate schedule. Smaller per horsepower rebates are offered for motors in new applications to reflect the marginal costs of high efficiency motors, while larger rebates are offered for the replacement of standard efficiency motors in existing applications. In addition to providing rebates, NSP offers its customers free motor testing to demonstrate the potentials for energy-efficient motors. Vendors of energy-efficient motors are also provided with rebates and are treated specially, as NSP considers its trade allies very important to the success of the program.

For adjustable speed drives, NSP offers several rebate levels based on the size of the drive. The highest per horsepower rebates are offered for smaller applications, while the per horsepower rebate is reduced for larger applications.

NSP has also taken direct steps to overcome one of the classic problems with moving customers to the use of energy efficient motors: many motors are embedded in pieces of equipment, such as compressors and fans. As such, NSP offers rebates to its customers for motors in "OEM or original equipment manufacturer" applications. Thus customers will put pressure on OEM manufacturers by specifying energy efficient motors in these applications.

Another attractive aspect of NSP's Motors and Drives program design is that purchases of energy-efficient equipment can be financed through NSP's Energy Financing program. While used almost exclusively for lighting installations to date, NSP disbursed close to $11 million in low-interest loans for energy-efficient equipment to its commercial and industrial customers in 1992. The intent of the financing program is to facilitate participation in DSM programs by removing the up-front financial barrier of purchasing conservation measures. Customers pay back their loans on their NSP bill, using a mechanism similar to an energy service charge.

## Motors and Drives

| | |
|---|---|
| Utility: | Northern States Power Company |
| Sector: | Commercial and industrial |
| Measures: | High-efficiency motors and adjustable speed drives |
| Mechanism: | Rebates for installation of energy-efficient motors and ASDs. Two tiered rebate schedule for motors, rebates for ASDs on sliding scale based on horsepower |
| History: | Motors component began in 1986; ASD component began in 1992 |

### 1993 YTD Program Data

| | |
|---|---|
| Energy savings: | 6.6 GWh |
| Lifecycle energy savings: | 131.7 GWh |
| Capacity savings: | 1.6 MW |
| Cost: | $895,100 |

### Cumulative Data (1986 - 1993 YTD)

| | |
|---|---|
| Energy savings: | 70.6 GWh |
| Lifecycle energy savings: | 498.5 GWh |
| Capacity savings: | 5.2 MW |
| Cost: | $2,630,700 |

### 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 U.S. Federal Reserve's foreign exchange rates.

*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.

**Data Alert:** The data contained in this section reflects the utility's activities in North Dakota, South Dakota, Minnesota, Wisconsin, and Michigan. All remaining sections in this profile reflect NSP's Minnesota activities only.

Northern States Power Company (NSP) of Minneapolis, Minnesota is an investor-owned utility providing gas and electric service to 1.3 million customers throughout Minnesota, Wisconsin, North Dakota, South Dakota, and Michigan's Upper Peninsula. NSP has several subsidiaries through which it delivers electricity, gas, and other services. NSP-Minnesota operates in Minnesota, North Dakota, and South Dakota, and NSP-Wisconsin operates in Wisconsin and Michigan. In addition, NRG Energy, Inc. is a wholly-owned subsidiary based in Minneapolis and is engaged in non-utility energy business activities. NSP Lands, Inc. held by NSP-Wisconsin, develops and markets surplus NSP property. NSP had a total of 7,522 employees in 1992.[R#1]

The NSP-Wisconsin service territory includes much of western Wisconsin including the cities of Eau Claire (population 51,000) and La Crosse (population 48,000). The NSP-Wisconsin service area extends into a portion of Michigan's Upper Peninsula. The NSP-Wisconsin area is contiguous with the part of NSP-Minnesota's service area that includes southern Minnesota (and the cities of Minneapolis and St. Paul) and a small portion of southeast South Dakota around the city of Sioux Falls (population 81,000). NSP-Minnesota also serves customers in an area of northwest Minnesota and eastern North Dakota, around the cities of Fargo and Grand Forks, North Dakota. Additionally, NSP-Minnesota's electric service territory includes a section around the town of Minot, in central North Dakota. NSP provides gas service to 380,000 customers in portions of its service territory in North Dakota, Minnesota, Wisconsin, and Michigan.[R#1]

NSP owns 6,798 MW of generating capacity and purchases 1,614 MW, for a total of 8,412 MW. Peak demand of 6,128 MW occurred on June 12 in 1992. The reserve margin in 1992 was 37.3%. NSP owns 79% of its total generating capacity, made up of 47% coal, 28% nuclear, 3% hydro, and 1% from other sources. Purchased power and interchange makes up the remaining 21% of NSP's capability; a total of 11% of the capability is purchased hydroelectricity from Canada. NSP is increasing its ability to purchase hydropower from Manitoba Hydro by increasing the capacity of the 500 kV interconnection between Winnipeg, Manitoba, and Minneapolis-St. Paul. Additionally, the company is building two new 100 MW natural gas or oil-fired combustion turbines near Sioux Falls, South Dakota.[R#1]

**NSP 1992 ELECTRIC STATISTICS**

| | |
|---|---|
| Number of Customers | 1,347,666 |
| Electricity Sales | 37,172 GWh |
| Electricity Sales Revenues | $1,694 million |
| Peak Demand | 6,128 MW |
| Generating Capacity | 8,412 MW |
| Reserve Margin | 37.3 % |
| **Average Electric Rates** | |
| Res. With Space Heating | 5.66 ¢/kWh |
| Res. Without Space Heating | 6.50 ¢/kWh |
| Small C/I | 5.56 ¢/kWh |
| Large C/I | 4.08 ¢/kWh |

In 1992, NSP electric customers used 37,172 GWh. Most of this electricity (16,365 GWh or 44%) was used by NSP's 7,904 large commercial and industrial customers. The company's 140,768 small commercial and industrial customers purchased 5,224 GWh (14%). Of NSP's residential customers, 74,939 have electric space heating and these customers purchased 1,041 GWh in 1992, for an average annual use of 13,950 kWh per customer. The 1.12 million residential customers without electric space heat used 7,640 GWh and had average annual electricity use of 6,879 kWh per customer. Thus, residential customers used a total of 8,681 GWh (23%). In 1992, NSP also sold 372 GWh (1%) for street lighting and other uses, and 6,530 (18%) GWh for resale. Electric revenues totaled $1.69 billion for 1992.[R#1]

NSP corporate contributions totaled approximately $4 million in 1992, helping to fund 960 nonprofit agencies. As a result of these efforts, NSP received the Responsive Philanthropy Award from the Minnesota Council of Nonprofits as the corporation with the highest percentage of contributions funding organizations that serve or advocate for the poor.[R#1] ■

# Utility DSM Overview

In 1992, NSP achieved 175,000 MWh of energy savings and 107 MW of coincident peak demand reduction as a result of its portfolio of DSM programs. From 1988 through 1992 DSM energy savings totaled 446 GWh and coincident demand savings totaled 443 MW. NSP spent $24.6 million on its DSM programs in 1992, equal to 1.45% of electricity sales revenues. The utility has been involved with DSM activities since the mid 1970s.[R#2,7]

In 1992 NSP's Energy Financing program disbursed close to $11 million in low-interest loans for energy-efficient equipment to commercial and industrial customers. Almost all of these loans were for energy-efficient lighting systems. The program provides loans for up to five years to C&I customers who qualify for NSP's conservation programs. The minimum loan provided is $500 and the maximum loan depends on annual peak demand, with a ceiling of $500,000. The interest rate is 9% and loans must be secured by the equipment being purchased. The intent of the program is to facilitate participation in DSM programs by removing the up-front financial barrier of purchasing conservation measures. Customers pay back their loans on their NSP bill.[R#2] (For another example of an energy service charge mechanism, see The Results Center Profile #46)

As an example of an impact of one of NSP's DSM programs, the utility was instrumental in providing energy-efficient lighting for the Science Museum of Minnesota. For a total project cost of $30,000, NSP was able to provide the museum with annual electric bill savings of $20,000. To make the retrofit that much more attractive to the museum, NSP provided the museum a $12,000 rebate, effectively reducing the museum's payback on the retrofit to one year! In terms of savings, the retrofit resulted in a reduction of 100 kW of lighting capacity and 600 MWh of energy annually, while maintaining 100% of the pre-retrofit light output.[R#5]

In 1992 NSP's Appliance Recycling program accounted for the recycling of 10,000 appliances in the last three months of the year. The utility picks up and recycles residential customers' old, but working, inefficient refrigerators,

**NSP DSM PROGRAMS**

*Residential*

- Services for Low Income Customers
- Citywide Advisory Committee (CACHIE)
- Conservation Seminars
- Home Energy Audit
- Appliance Efficiency
- Appliance Recycling
- Attic Reinsulation
- Conservation Merchandising
- Energy Grants

*Commercial/Industrial*

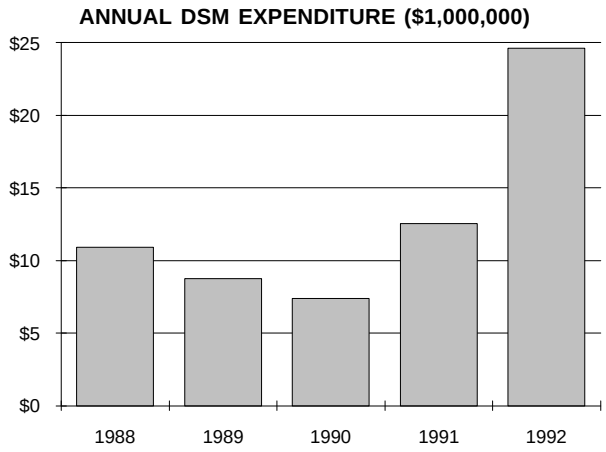
- Energy Audit for Business
- Local Government
- Commercial Partnership Program
- NSP Energy Financing
- **Adjustable Speed Drives**
- **Motor Efficiency**
- Chiller Efficiency
- Cooling System Replacement
- Humidification Efficiency
- Glazing Efficiency
- Industrial DSM Incentive
- Lighting Efficiency
- Refrigeration Efficiency
- Rooftop Efficiency
- State of Minnesota Retrofit Program

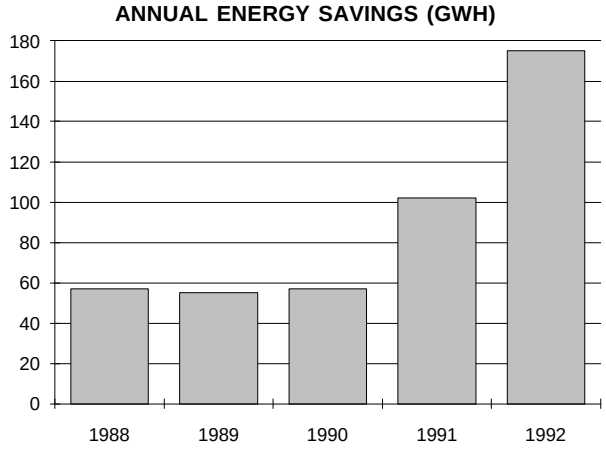
*Load Management*

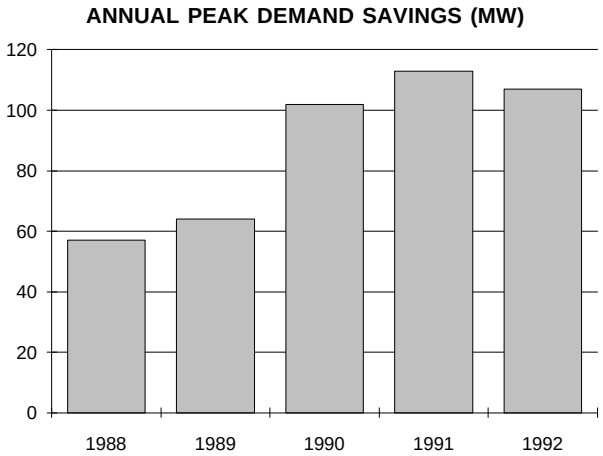
- Peak - Controlled Rate
- Energy - Controlled Rate
- Saver's Switch
- Cool Storage
- Limited Off - Peak Service Rate
- Time - of - Day Rate

*Other*

- Small Business Lighting
- Farm Programs




| DSM Overview | *Annual DSM Expenditure (x1000)* | *Annual Energy Savings (GWh)* | *Annual Peak Demand Savings (MW)* |
|---|---|---|---|
| 1988 | $10,938 | 57 | 57 |
| 1989 | $8,748 | 55 | 64 |
| 1990 | $7,400 | 57 | 102 |
| 1991 | $12,549 | 102 | 113 |
| 1992 | $24,621 | 175 | 107 |
| Total | $64,256 | 446 | 443 |

freezers, and window air conditioners. NSP estimates that there are 250,000 appliances in their service territory that could be removed through the program.[R#1,2] (See The Results Center Profiles #10, #24)

The utility's DSM goal is to reduce cumulative peak demand by 1,100 MW by 1995 and 1,700 MW by the year 2000. NSP has begun the process of shifting its DSM emphasis from load management to promote both energy conservation and load management programs.[R#1] For 1993, the utility hopes to achieve 142 MW of demand savings and 241,000 MWh of energy savings with DSM expenditures totaling $41.3 million.[R#7] ■

# Program Overview

Northern States Power Company first offered its Motor Efficiency program in 1986. The Adjustable Speed Drive (ASD) component was added in April 1992 and the two programs are currently marketed together. NSP provides rebates to commercial and industrial customers who install high-efficiency motors and/or ASDs. As a result of the program customers achieve consistent energy savings while the utility is able to reduce its peak demand. The potential for motor and drive savings is quite dramatic as electric motor energy use accounts for approximately 1/3 of NSP's summer peak demand.[R#4]

In addition to addressing motor purchases for new applications, NSP recognizes that there is an additional market potential for replacing existing, working motors as well. As such, higher rebates are available for customers willing to "swap out" operable, standard efficiency motors for new energy-efficient motors. Rebates for new applications are $5/hp versus $11/hp for replacing operable motors. Energy-efficient motors have the greatest conservation potential in measures such as fans, pumps, compressors, and process equipment. The savings potential for the ASD program lies primarily in processes or systems with a high degree of throttling; a high percentage of operating time; and large horsepower (50 hp or larger).[R#4] ■

## BENEFITS OF HIGH-EFFICIENCY MOTORS AND ASDS

In addition to using less electricity and reducing operating costs, high-efficiency motors have many additional benefits over standard motors. High-efficiency motors operate more quietly; motor, insulation, and bearing life are increased because of cooler operating temperatures; they typically require fewer repairs; and the more hours these motors operate, the greater the energy and dollar savings.

This is the result of the fact that energy-efficient motors have higher quality and thinner steel laminations in the stator; more copper in the windings; a smaller air gap between the rotor and stator; reduced fan losses; and closer machining tolerances.[R#4] (See Results Center Profile #45 for additional benefits of high-efficiency motors)

For customers running processes and systems without adjustable speed drives (ASDs), they may be operating in a manner similar to driving a car on the highway with the gas pedal fully depressed, controlling the speed with the brake. ASDs conserve energy by controlling the speed of AC induction and synchronous motors and driven equipment. By not using ASDs customers waste energy and put unnecessary stress on their equipment. Motor speed control offers the single largest opportunity for energy savings in drivepower systems.[R#4,8]

Other benefits from ASDs include lower energy bills, longer equipment life, reduced maintenance costs, improved process control, and the potential for product quality improvement.[R#8]

Purchasing energy-efficient motors and ASDs requires a capital investment, especially when comparing the cost of purchasing new energy-efficient motors versus the cost of rewinding a standard efficiency motor that an industry already owns. To further discourage an interested customer, energy-efficient motors are not always in stock and available when motors break down and need to be replaced immediately. The installation of ASDs can produce unwanted power supply effects such as harmonic distortion or nuisance tripping. Because of these barriers, NSP and other utilities have developed programs that raise customers' awareness of the lifecycle benefits of energy-efficient equipment, and then couple this with direct financial incentives.

## MARKETING

The Motors and ASD programs are marketed through NSP marketing representatives, NSP's quarterly customer newsletter covering all its DSM program opportunities, trade allies (including dealers, distributors, and manufacturers), educational seminars and workshops, direct mail, trade show participation, and other public relations vehicles.[R#3]

Each year NSP hosts two trade ally expos to raise awareness of all its DSM programs and to cover specific technical issues. The expos are based around the theme, "Helping you help your customers." Expos feature a morning plenary session, a luncheon keynote speaker, and then breakout sessions in the afternoon for more technical briefings on subjects ranging from power quality issues to motors, ASDs, and lighting product developments. The expos are announced using direct mailings to over 6,000 trade allies and the last expo attracted an impressive 170 participants. In addition to the trade ally expos, NSP hosts an annual "trade ally appreciation banquet."[R#3]

The target industrial market segments for the Motors and Drive program include food processing, paper products, petroleum refining, electrical machinery/scientific instruments, and non-electrical machinery. The target commercial market segments are services, public institutions, wholesale and retail trade, finance, insurance, and real estate. The fastest growing industrial markets in terms of motor use are chemicals, printing and publishing, primary metals, lumber, and petroleum refining.[R#3,8]

In both 1992 and 1993 direct mail pieces were sent to trade allies and customers announcing increased motor rebates. A sales kit was sent to motor and ASD distributors which provided program information and sales tools. NSP also hosted a workshop in 1992 on motors and ASDs in cooperation with the Electric Power Research Institute (EPRI). A similar conference was held in September 1993.[R#3]

In 1992 the utility updated its multi-page brochure on the Motors and ASD programs to include new motors rebates and simplified cost/savings calculations examples. The rebate forms that accompany the brochure were also simplified.[R#3]

Most recently NSP has run a special promotion for the programs which has resulted in quite dramatic increases in program participation. Through the promotion NSP is offering 20% additional rebates for Plan B motors (in other words instead of $11/hp the utility is providing $13.20/hp) and a 50% rebate increase for the vendor rebate ($1.50/hp instead of $1.00/hp). The promotion has been advertised with a direct mail piece sent to 12-13,000 commercial and industrial customers with loads over 150 kW and to a few hundred trade allies. In addition, the promotion has been announced in NSP's quarterly DSM newsletter, at the recent September 1993 motors workshop, and has been promoted by customer representatives. The promotion will also be "pumped up" at the November 1993 trade ally banquet.[R#3]

## DELIVERY

### MOTOR EFFICIENCY PROGRAM

Customers have the option of purchasing motors under any combination of the following two plans.

Plan A: NSP offers a $5/hp rebate for the installation of motors in a new application or the replacement of non-working ("burnt-out") motors.[R#4]

High-efficiency motors from 3 hp to 400 hp qualify for rebates when they meet or exceed NEMA's nominal full load efficiencies for energy-efficient motors. (See The Results Center Profile #45 for a table of these efficiencies) In addition qualifying motors must be AC polyphase induction motors; have a squirrel cage rotor design; NEMA design B Torque characteristics; and speeds of 900, 1,200, 1,800, or 3,600 rpm. NSP hopes to increase the efficiencies of qualifying motors in future years in order to stay ahead of standard developments. The utility also hopes to include single phase motors along with 1, 1.5, and 2 hp motors. Plans are also in the works for customized rebates for motors over 400 hp.[R#4]

Plan B: A rebate of $11/hp is available for retrofits of currently operating motors. Retrofit replacement motors must have horsepower equal to or lower than the horsepower of the motors being replaced. Interested customers must have NSP approve their rebate application before an old motor is replaced.[R#4] ☞

Under both plans, customers must apply for the rebate within 12 months of purchasing the high-efficiency motors. Participating customers must complete an application form, attach a copy of the invoice detailing the motor specifications, and send this information to their NSP Regional Marketing Representative.[R#4,8]

In addition, high-efficiency equipment such as HVAC systems or air compressors do not necessarily contain high-efficiency motors. If NSP customers specify qualifying high-efficiency motors in original equipment manufacturers' (OEM) equipment, these motors are eligible for the Motor Efficiency program rebate as well.[R#4]

NSP also offers an incentive for high-efficiency motor sales. The distributor's salesperson is eligible for a $1/hp rebate.[R#4]

Customers participating in the Motors and ASD programs are eligible for NSP's Energy Financing program. Rebates from the Motors and ASD programs are applied as credit against the loan. To date, the Financing program has predominantly attracted lighting projects.[R#3,4,8]

NSP also offers motor testing and analysis to determine the actual efficiency while in use. The tests are free, performed by NSP staff, and are done to help customers gain an awareness of the potentials for increasing the efficiency of their motors by providing them with a vivid display of their current operating efficiency.[R#4]

The MotorMaster database is available to interested customers through NSP.[R#4] (See The Results Center Profile #45)

#### ADJUSTABLE SPEED DRIVE (ASD) PROGRAM

Qualifying ASDs are eligible for cash rebates per horsepower. For ASDs up to 200 hp, customers receive a rebate of $70 per hp. For ASDs between 250 and 900 hp, NSP pays $30 per hp. And for ASDs exceeding 1,000 hp, customers are eligible for a rebate of $20 per hp.[R#4,8]

Customers interested in the ASD program must receive a prescreening analysis from NSP. Customers who are unlikely to qualify for the program are notified at this point. If additional information is required, NSP will pay for 75% or up to $5,000 of the cost of an engineering study. Preapproval for reimbursement must be received before the study is performed.[R#4]

If the engineering study recommends a retrofit, customers then apply for pre-approval. After receiving this approval, customers can purchase and install ASDs. A rebate application form is then submitted with the ASD invoice for a rebate. ASDs can qualify in both new and retrofit situations. If a new motor is installed within the ASD application process, the motor must meet NSP's Motor Efficiency program standards in order to receive a rebate.[R#8]

## MEASURES INSTALLED

High-efficiency motors qualifying for the program range from 3 hp to 400 hp with speeds from 900 rpm (revolutions per minute) to 3600 rpm.[R#4]

The three most readily available types of ASDs are the current source inverter (CSI), the voltage-source inverter (VSI), and the pulse-width-modulated (PWM) drive. Typical applications for ASDs include: process pumps, water pumps, chilled water pumps, condensate pumps, ventilation and cooling fans.[R#4]

## STAFFING REQUIREMENTS

The Motor Efficiency and ASD program is run by Product Manager Teresa DeYoe who devotes approximately 1/3 of her time to the program. The program has a full-time technical support person who among other duties performs the field testing of motors. NSP has 100 customer service representatives who promote these and other programs.[R#3] ■

## MONITORING

The program's impact is primarily tracked via customer representatives in the field who feed information to NSP's marketing information system (which goes by the acronym "MKS"). MKS provides a means of tracking a customer's entire history including rebates and participation in all DSM programs. Every time a customer representative visits a customer, a record of the meeting is entered into the MKS. If the customer files an application for a motor or ASD rebate, a record is also made in MKS, and this information in turn is provided to Teresa DeYoe, the product manager. At the time of the application, the record bears the distinction of being "committed pending" or "CP". At that point the paperwork is forwarded to the processing department which checks the application for program eligibility and then makes the payment to the customer. After payment is complete, the record is provided to Teresa DeYoe with an "AP" or "approved payment" distinction.[R#3]

Every week Teresa DeYoe receives a report from the processing department that provides her with both a tally of committed pending rebates as well as approved rebates. As such she can quickly track the program's success to date in terms of capacity, energy, number of participants, and as a percentage of the program's goals for the year for both motors and drives. She is also provided a monthly report with summary data.[R#3]

Customer representatives are responsible for making sure that motors which have been rebated are indeed in service in the field. Given the volume of motors and rebates, the customer representatives can only verify a representative selection of the motors placed in service as a result of the program. For larger customers, such as the Coca Cola bottling facility in NSP's service territory (which replaces motors seemingly every week), the NSP customer representative is often present, assuring NSP program planners that the majority of motors in place (and more importantly the majority of the capacity of energy-efficient motors in place) fulfill the Motors and ASDs program criteria.[R#3]

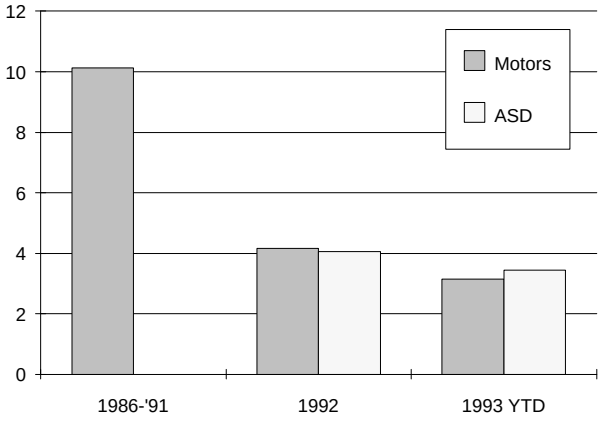
## EVALUATION

To date, NSP has not performed any formal process or impact evaluations but plans to hire a consultant to perform an impact evaluation for the program in 1994. ■

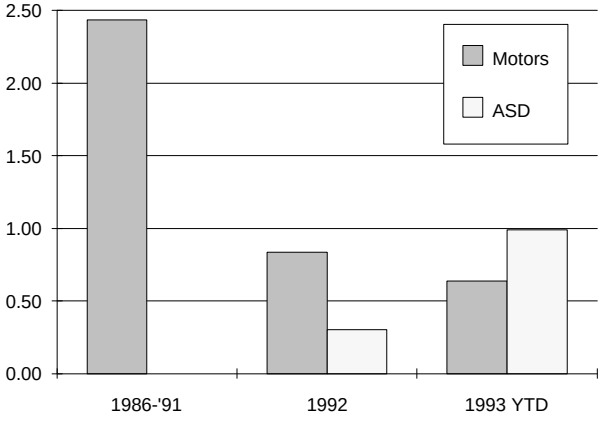
# Program Savings

| **Savings Overview** | *Annual Energy Savings (MWh)* | *Cumulative Energy Savings (MWh)* | *Lifecycle Energy Savings (MWh)* | *Annual Capacity Savings (MW)* | *Cumulative Capacity Savings (MW)* |
|---|---|---|---|---|---|
| Motors | | | | | |
| 1986-'91 | 10,137 | 10,137 | 202,740 | 2.436 | 2.436 |
| 1992 | 4,149 | 14,286 | 82,980 | 0.835 | 3.271 |
| 1993 YTD | 3,146 | 17,432 | 62,920 | 0.639 | 3.910 |
| Total | 17,432 | 59,107 | 348,640 | 3.910 | |
| ASDs | | | | | |
| 1992 | 4,046 | 4,046 | 80,920 | 0.303 | 0.303 |
| 1993 YTD | 3,438 | 7,484 | 68,760 | 0.991 | 1.294 |
| Total | 7,484 | 11,530 | 149,680 | 1.294 | |

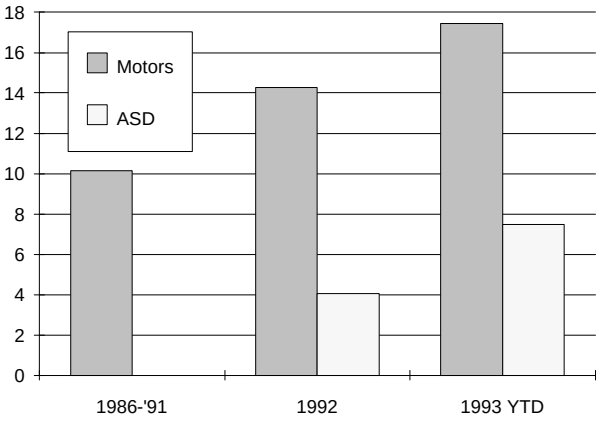
**ANNUAL ENERGY SAVINGS (GWH)**



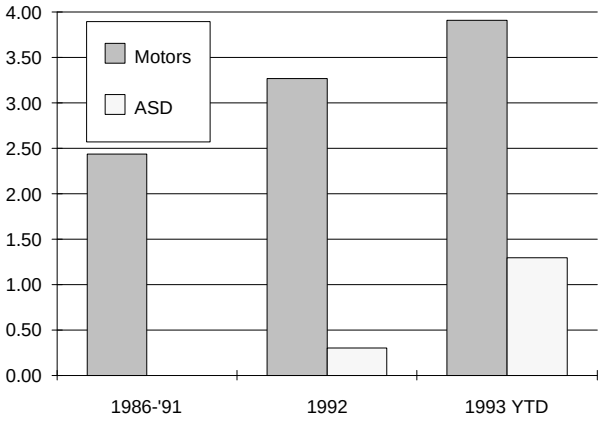

**ANNUAL CAPACITY SAVINGS (MW)**




**CUMULATIVE ENERGY SAVINGS (GWH)**




**CUMULATIVE CAPACITY SAVINGS (MW)**



**Data Alert:** Savings figures for 1993 reflect program activity through August 1993 and are included in the cumulative program totals. Capacity savings for 1986 through 1991 reflect non-coincident savings, while capacity savings for 1992 and 1993 are coincident savings. Note also that MWh savings values for 1988 are not available. All savings values presented reflect raw engineering estimates and have not been adjusted for free ridership, free drivership, or any other factors. Participation numbers for 1992 and 1993 reflect both the Motors and ASDs programs.[R#3]

In 1992 the Motor Efficiency program accounted for 4,149 MWh in energy savings and 835 kW in capacity savings. Through August of 1993, the Motors program saved 639 kW and 3,146 MWh. Total annual energy savings for the Motors program are 17,432 MWh and total lifecycle savings are 348,640 MWh. The Motors program has achieved total cumulative savings of 59,107 MWh.[R#3,8]

The ASD program had savings of 303 kW and 4,046 MWh in 1992. Through August 1993, the ASD program saved 991 kW and 3,438 MWh. Total annual energy savings for the ASD component are 7,484 MWh, total lifecycle energy savings are 149,680 MWh, total cumulative energy savings are 11,530 MWh and cumulative capacity savings are 1.294 MW.[R#3,8]

## PARTICIPATION RATES

Participants are defined as NSP customers who receive rebates through the Motor Efficiency and ASD programs. In 1992, participation increased dramatically with 291 participants, more than twice the level of participation in 1991. Previously, the year having the greatest program participation was 1990 with 135 participants. Through August of 1993, the combined programs' participants have totalled 252. A total of 1,039 customers have participated in the program from 1987 through August 1993. (Note that the number of participants in 1986 is not available, though NSP staff estimate that there were less than 50 participants in 1986, the first year of the program.)[R#3]

## FREE RIDERSHIP

Note that the savings values presented are based on engineering estimates and are not adjusted. The utility believes that free ridership is relatively low due to the fact that rebate levels had to be raised significantly in 1993 in an attempt to increase participation and that without the increases, participation was very low. On the other hand, NSP's work with trade allies (such as motor vendors), and with generally raising the awareness of its customers of the benefits of energy efficient motors, has likely resulted in some level of "free drivership," a level that approximately negates any free ridership experienced on the system as a result of the program.[R#3,5]

Other motor programs profiled by The Results Center have estimated free ridership levels of 11% and 23%. (See Profiles #38, #41)

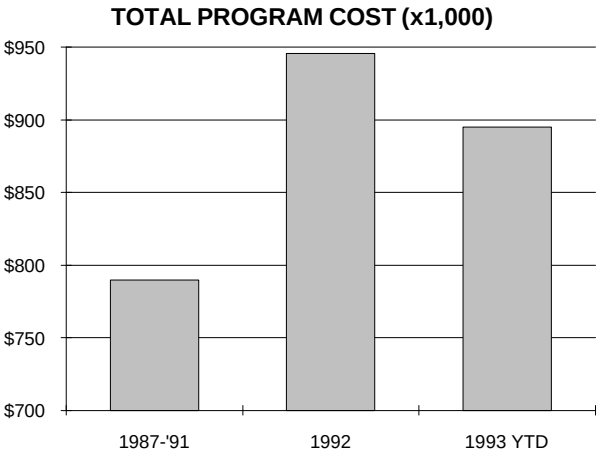
| **Participation** | *Participants* | *Annual Energy Savings per Participant (kWh)* |
|---|---|---|
| 1986-'91 | 496 | 20,438 |
| 1992 | 291 | 28,162 |
| 1993 YTD | 252 | 26,127 |
| Total | 1,039 | |

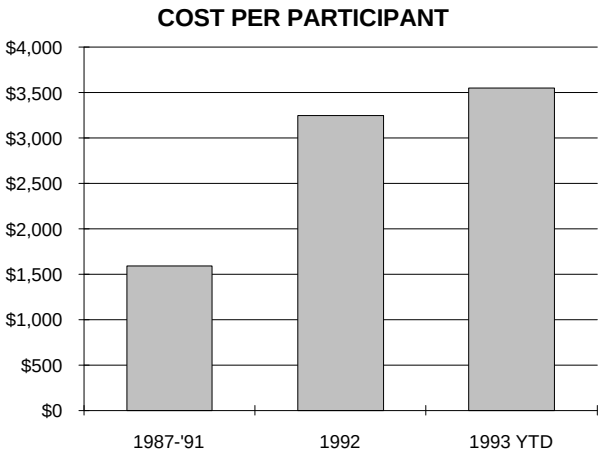
## MEASURE LIFETIME

NSP assigns an average measure lifetime of 20 years to the Motors and ASD programs. This lifetime is based on an average physical motor life without early changeout due to drivepower reconfiguration. ■

# Cost of the Program

| Costs Overview | *Total Program Cost (x1000)* | *Cost per Participant* |
|---|---|---|
| 1987-'91 | $789.9 | $1,592.54 |
| 1992 | $945.7 | $3,249.87 |
| 1993 YTD | $895.1 | $3,551.83 |
| Total | $2,630.7 | |




| **Cost of Saved Energy (¢/kWh)** | *Discount Rates* | | | | | | |
|---|---|---|---|---|---|---|---|
| | 3% | 4% | 5% | 6% | 7% | 8% | 9% |
| 1987-'91 | 0.52 | 0.57 | 0.63 | 0.68 | 0.74 | 0.79 | 0.85 |
| 1992 | 0.78 | 0.85 | 0.93 | 1.01 | 1.09 | 1.18 | 1.26 |
| 1993 YTD | 0.91 | 1.00 | 1.09 | 1.19 | 1.28 | 1.38 | 1.49 |

**Data Alert:** Program expenditures for 1987-1991 reflect costs of the Motors program only. Program costs for 1986 are not available as they were never disaggregated from all of NSP's commercial and industrial program costs. Costs for 1992 and 1993 (through August 1993) reflect both the Motor Efficiency and ASDs programs.[R#3]

In 1992, NSP spent a combined total of $945,700 on the Motor Efficiency and ASDs programs. Expenditures increased dramatically in 1992, compared to 1991 expenditures of $260,600 due in large part to the start of the ASD component as well as increased rebate levels for energy-efficient motors. Through August of 1993, NSP spent a total of $895,100 on the programs. From 1987 through 1991, NSP spent a total of $789,800 on the Motor Efficiency program. Expenditures for the program to date total $2,630,700.[R#3]

## COST EFFECTIVENESS

Northern States Power is required to analyze the cost effectiveness of all of its DSM programs prior to implementing the programs. When done for the revised 1992 Motors and ASDs program, the utility found that the motors component (Plans A&B) had an estimated lifetime value of 0.3¢/kWh, while the drive component had a lifetime cost/kWh of 1¢/kWh. Note that these values were projections and are not discounted for the cost of capital.[R#5]

Per its convention, The Results Center calculated the cost of saved energy for the Motor Efficiency and ASDs programs for 1987 through 1993. Based on a 5% discount rate, the cost of saved energy was 0.63 ¢/kWh for the 1987-1991 motors-only program. In 1992 with the program ramped-up to full strength and expanded to provide incentives for ASDs as well, the cost of saved energy at a 5% discount rate was an impressive 0.93 ¢/kWh. Through August 1993, the cost of saved energy is 1.09¢/ kWh. These values indicate a program that has obviously delivered a lot of bang for the buck!

## COST PER PARTICIPANT

In 1992, NSP's cost per participant was $3,250, approximately double the 1987-1991 program cost per participant of $1,593 which reflected a far different, and far less aggressive program. For the year to date (through August 1993), the program's cost per participant has been $3,552.[R#5]

Note that for both Plan A and B, NSP estimates that it pays 20-25% of the cost of energy-efficient motors, essentially covering the marginal cost to the customer of efficient motors.[R#3]

## COST COMPONENTS

While detailed cost breakdowns for the program are not available, NSP has provided figures on the relative costs between customer rebates and total program costs which reflect the maturation of the program. For instance, in 1987 customer rebates of approximately $25,000 (unlevelized) accounted for about 25% of the total program cost. By 1989 the proportion of total program costs provided directly to customers increased to about 30%. In 1993, fully 75% of the total program cost year to date has been expended on customer rebates. As of August 1993, NSP has provided an impressive $654,815 in customer rebates, out of a total cost of $895,061.[R#3]

NSP also provided an early estimated budget breakdown for 1993 which serves as a guide to the relative values of the program's costs. For the 1993 budget, NSP allocated $424,000 for incentives, $399,019 for program delivery costs, $383,000 for consulting services, $78,000 for administration labor, $3,000 for other project administration costs, $32,000 for advertising, and $3,000 for other expenses.[R#3] ■

# Environmental Benefit Statement

**AVOIDED EMISSIONS: Based on 70,637,000 kWh saved 1986 - 1993 YTD**

| 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% | 152,293,000 | 3,613,000 | 730,000 | 73,000 |
| B | 10,000 | 1.20% | 162,394,000 | 1,399,000 | 472,000 | 350,000 |
| | **Controlled Emissions** | | | | | |
| A | 9,400 | 2.50% | 152,293,000 | 361,000 | 730,000 | 6,000 |
| B | 10,000 | 1.20% | 162,394,000 | 140,000 | 472,000 | 23,000 |
| C | 10,000 | | 162,394,000 | 932,000 | 466,000 | 23,000 |
| | **Atmospheric Fluidized Bed Combustion** | | | | | |
| A | 10,000 | 1.10% | 162,394,000 | 427,000 | 233,000 | 117,000 |
| B | 9,400 | 2.50% | 152,293,000 | 361,000 | 292,000 | 22,000 |
| | **Integrated Gasification Combined Cycle** | | | | | |
| A | 10,000 | 0.45% | 162,394,000 | 287,000 | 47,000 | 117,000 |
| B | 9,010 | | 146,077,000 | 104,000 | 35,000 | 7,000 |
| **Gas** | **Steam** | | | | | |
| A | 10,400 | | 88,579,000 | 0 | 202,000 | 0 |
| B | 9,224 | | 76,924,000 | 0 | 482,000 | 23,000 |
| | **Combined Cycle** | | | | | |
| 1. Existing | 9,000 | | 76,924,000 | 0 | 295,000 | 0 |
| 2. NSPS* | 9,000 | | 76,924,000 | 0 | 140,000 | 0 |
| 3. BACT* | 9,000 | | 76,924,000 | 0 | 19,000 | 0 |
| **Oil** | **Steam--#6 Oil** | | | | | |
| A | 9,840 | 2.00% | 128,206,000 | 1,943,000 | 229,000 | 218,000 |
| B | 10,400 | 2.20% | 135,976,000 | 1,927,000 | 288,000 | 140,000 |
| C | 10,400 | 1.00% | 135,976,000 | 275,000 | 232,000 | 73,000 |
| D | 10,400 | 0.50% | 135,976,000 | 808,000 | 288,000 | 44,000 |
| | **Combustion Turbine** | | | | | |
| #2 Diesel | 13,600 | 0.30% | 170,165,000 | 339,000 | 526,000 | 29,000 |
| **Refuse Derived Fuel** | | | | | | |
| Conventional | 15,000 | 0.20% | 202,022,000 | 521,000 | 685,000 | 152,000 |

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 accomanying page is to allow any user of this profile to apply Northern States Power's level of avoided emissions saved through its Motors and Drives 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

Two major changes have taken place with the Motors and ASDs programs in recent years. First, the rebate levels in 1992 for the Motors component were dramatically increased for new application and replacement motors from $2/hp to $5/hp and rebates for retrofits of operating motors increased from $7/hp to $11/hp. These changes were made in an attempt to increase program participation. In addition to the major structural program changes introduced in 1992, in mid-1993 NSP further promoted the program by using a special limited time frame promotion which provided even greater incentives for both customers and vendors. This resulted in quite dramatic increases in participation, further accelerating the pace of program participation and commensurate savings.[R#3]

Second, NSP has placed much greater emphasis on program marketing. The utility does much more direct marketing than it did in the program's early years, and also holds periodic motors and drives workshops. NSP staff emphasize the importance of trade allies to the success of the program. Both of these points relate to the fact that the use of motors in our society (primarily in commercial and industrial applications) is deeply ingrained and embedded. Thus making significant changes to the motor infrastructure is indeed a very challenging task which requires diligent promotional and awareness-raising efforts.[R#3,5]

Finally, perhaps the most important lesson learned by the NSP staff is the complexity of trying to increase the efficiency of drivepower systems. Providing incentives for energy-efficient motors may be only the tip of the iceberg. Utilities have to assess how to best improve the efficiency not only of the motors, but the loads "downstream" of the motors. Downstream, in other words the farther down the torque shaft that you get (approaching pumps, fans, compressors, pneumatics, etc.), provides other opportunities for savings that may have profound upstream effects potentially resulting in far more important savings. Thus NSP staff have begun learning how to improve the efficiency of industrial processes (that could even negate the need for certain motors), how to maintain lubrication of gears and the like (the field of tribology), not to mention the sizing issues surrounding motors and drives. These deeper issues underscore the complexity of motor and drivepower applications and the difficulty in focusing on motors and drives which represent important elements of these systems. NSP has recognized the need for such increased sophistication by initiating a customized program, Business Energy Grants.[R#5]

## TRANSFERABILITY

As a standard rebate program, the fundamental design of NSP's Motor Efficiency and ASD program is transferable to other utility service territories with minor modifications. Of course, setting the appropriate rebate level is challenging, and is not only a function of marginal costs of energy-efficient motors and drives, but must also be a function of vendor and customer awareness and experience with energy-efficient equipment, the applications for motors within a service territory (and thus motor enclosure types, degree of use of OEM equipment, the competitive nature of major industries within a service territory, etc.), current stocking and pricing practices, as well as general knowledge.

When considering transferring the basic concept of NSP's motor and drive rebate program to other service territories several other factors must be considered:

1. Several utilities have been concerned that providing rebates for horsepower may lead to unwise investments of ratepayer monies. Why? Simply, many motors in service are oversized and are thus operating at part loads which translates into inefficient operations. Rather than providing incentives based on horsepower, some utilities now provide incentives based on actual kW saved. By doing so, customers and vendors have an incentive to make sure that rebates are not being given for over-sized motors.

Furthermore, by incenting kW saved (versus horsepower) it is possible to provide higher incentives for customers who purchase premium efficiency motors. Note that even within the domain of high efficiency motors there is a spread of efficiency values between manufacturers. (See Profile #38 for an example of a motors program that focuses on saved kW versus horsepower rebates.)

NSP offers free motor testing to customers to determine the operating efficiency (a function of loading and the motor efficiency) of motors in service. This serves to promote replacements by educating customers of their current motors in service and the potentials to save money by moving towards energy-efficient motors in new and replacement applications.

2. Focusing on vendor incentives is also an important ingredient that must not be overlooked or deemphasized. To its credit, NSP has focused on vendors with some success. By incenting vendors (motor salespersons) at a fraction of the cost of customers, the motor market can be transformed. Note that given the complexity of motor enclosures, speeds, sizes, etc., many vendors can only carry one line of motors. By providing incentives directly to the vendors it may be possible to get the vendor to shift from standard motors to high efficiency motors at low cost. These trade allies — who already have credibility with their customers — can often serve to champion the program in ways more effective than a utility. (See also Profile #38)

3. As alluded to above in the lessons learned section, ultimately utility DSM programs may be able to enhance process efficiency improvements. By doing so, more systematic and potentially deeper energy savings may be captured, but unfortunately with far greater effort and complexity. While utilities may want to offer prescriptive rebates for energy-efficient motors and drives, ultimately they may find that focusing on the big picture (say of an industrial process) may yield the biggest savings, increase the competitiveness of the industry, and even allow for the attainment of parallel environmental objectives related to pollution prevention.

4. A final issue related to transferability relates to federal and state laws and codes. For instance, there is a provision in the National Energy Policy Act of 1992 related to motors, calling for all motors manufactured in 1997 to meet certain efficiency criteria. Similarly, in Minnesota, for example, the Minnesota State Building Code has recently been amended to encompass provisions for the efficiency of all new commercial construction, and includes a schedule of motor efficiencies that must be met in new construction. Naturally, program planners of motor programs will want to carefully examine how their program designs complement federal legislation and state codes that will effectively establish baseline efficiencies for motors over time. ■

# Regulatory Incentives and Shareholder Returns

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 we hope will provide useful snapshots of incentive mechanisms being used and tested across the United States. (Note that the dollar values in this section have not been levelized.)

## MINNESOTA OVERVIEW

The Minnesota Public Utilities Commission opened an investigation of financial incentives for demand-side management in May of 1989. In November of that year, Northern States Power filed a comprehensive DSM cost recovery and incentive proposal as part of its rate case. The rate case application, and proposed related rate increase, was rejected by the Commission for reasons not related to NSP's cost recovery and incentive proposal which NSP would reintroduce later.[R#9,10]

Integrated resource planning rules adopted in August of 1990 require utilities in Minnesota with more than 1,000 retail customers to file biennial resource plans.

The Minnesota Public Utilities Commission has taken steps in the past few years to reduce the barriers to, and to create incentives for DSM. In February of 1991 the Commission required all investor-owned utilities to file financial incentive proposals in 1991. Northern States Power, which had previously filed its proposal in 1990, reintroduced its proposal in a free standing filing instead of waiting to reintroduce the proposal in its next rate case. By the time that NSP did refile, the Omnibus Energy Act of the Minnesota state legislature provided the Commission the authority to approve shareholder incentives. The Act also required electric utilities in the state to spend 1.5% of revenues on conservation.[R#9,10]

NSP was seeking three things in its proposal. First it sought the ability to ratebase its DSM costs related to conservation programs. Second, it sought special lost revenue adjustments for its oversubscribed load management programs which were not eligible for cost recovery or shareholder incentives. Third, it sought a means of providing profit to its shareholders for investments in direct and indirect energy efficiency programs. (Indirect programs include audit programs, for example, that ultimately lead to savings.) Each of these three provisions were approved by the Commission in March of 1991 including a slightly modified bonus rate of return mechanism that tied expenditures to cost effectiveness and performance.[R#10]

## TREATMENT OF DSM EXPENDITURES

The March 1991 Commission decision allowed NSP to capitalize and amortize over a five-year period DSM program expenditures. DSM research and load management expenditures are expensed in the year incurred and recovered through the conservation Cost Recovery Account, or tracker account, rather than through conventional rate base accounting.[R#9]

## LOST REVENUES

Lost revenue recovery is not specifically permitted for conservation programs since the 5% equity kicker discussed below is viewed at least by some as a means of offsetting such losses. NSP, however, will be able to recover 50% of any interruptible rate discounts it offers which fall above levels built into the 1991 test year.[R#9]

## TREATMENT OF SHAREHOLDER INCENTIVES

The NSP incentive mechanism rewards the utility for DSM with a bonus rate of return mechanism. It allows the utility to capitalize and amortize over a five-year period al-

most all DSM project expenditures – except those for research and load management – and earn a 5% bonus rate of return on the unamortized portion of the capitalized expenditures. Previously, NSP expensed all DSM program costs. Note that the Commission selected the 5% bonus as high enough to provide an incentive, but not so high that the utility would be unduly rewarded. The Commission maintains the option to adjust this incentive based on DSM activity and performance over time.[R#9]

The actual bonus will vary depending on the utility's success in meeting pre-determined cost effectiveness, kWh savings, and participation goals. NSP must satisfy a two-threshold test to receive its shareholder incentive. First, the utility must achieve cost effectiveness results equal to at least 50% of its net avoided revenue requirement goal. If that threshold is met, the utility must then achieve either savings goals for direct impact projects, or weighted participation goals for indirect impact projects. The bonus return on ratebased DSM will vary linearly from 0% at 50% of goal achievement to 5% for 100% or more of goal achievement.[R#9]

One of the interesting issues in Minnesota is that since the Omnibus Energy Act of 1991 is the law, the Commission is concerned with providing incentives for expenditures as already required by law, potentially an unusual case of free ridership! While the hammer of the law was seen as powerful, the Commission specifically sought to provide rewards for superior performance, rather than relying on the law to promote effective programs. In fact, the Commission was concerned that without incentives, the utility would meet the letter of the law but not seek to run exemplary programs in the most effective means possible. Another issue that arose was one of equity between utilities. Otter Tail Power, also in Minnesota, for instance, was able to receive lost margin adjustments, while NSP was not since it was entitled to the equity-kicker incentive mechanism. (Interestingly, Minnesota Power did not seek shareholder incentives due to concerns about rate impacts.) Thus the Commission sought the optimal packet of incentives customized for maximum effect at each utility.[R#9,10]

The Minnesota Energy Consumers (MEC), a consortium of 21 industrial customers, challenged the Commission's authority to approve DSM incentives based on State Law, Minnesota Statute 216B.16, subdivision 6. The Commission interpreted the law differently and determined that it has broad statutory authority to approve financial incentives. The 1991 Omnibus legislation clarified and strengthened the Commission's authority in this regard. MEC was concerned that NSP might "gold-plate" its programs (spend too much for low levels of energy savings). The Department of Public Service, the designated intervener and consumer advocate, however, is expected to scrutinize all the utility's programs and thus prevent wasteful, cost-inefficient programs.

#### COMMENTS SPECIFIC TO NSP'S MOTORS AND DRIVES PROGRAM

For the purposes of incentive ratemaking, the Commission scores each of NSP's direct and indirect impact programs individually, and then bundles the results to determine the portfolio scoring for incentive purposes. As such, overperformance of one program can compensate for another program's suboptimal performance.[R#10] ■

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