Improving the Efficiency of Minnesota's Industries

By David Morris and Ann Robertson

November 1997

Executive Summary

In 1997 a unique bill was introduced in the Minnesota legislature: the Economic Efficiency and Pollution Reduction Act (EEPRA). In order to achieve environmental and economic goals, EEPRA reduces payroll and income taxes by $1.5 billion and increases fuel taxes by an equal amount.

Under EEPRA, energy-intensive businesses would pay higher net taxes while energy-efficient businesses would pay lower net taxes. While this is an intended outcome of the tax shift, businesses in Minnesota are concerned that the tax shift could impose a competitive burden on certain sectors. This report evaluates that issue by analyzing the impact of EEPRA on Minnesota's most energy-intensive business sectors and estimating the potential for those sectors to offset any increased tax burden through cost-effective efficiency improvements.

The report examines the 37 most energy-intensive sectors in Minnesota. These sectors' firms spend, on average, 4.8 percent or more of their sales revenue on energy. These sectors account for about 2.2 percent of Minnesota's industrial output.

EEPRA would increase the gross energy costs of these businesses, on average, by about 30 percent. EEPRA provides for a conditional and partial exemption from the tax shift for energy-intensive firms. All firms in our analysis would qualify for the highest exemption—75 percent. This exemption applies to both the energy tax increase and the payroll tax decrease (a reduction of about 21 percent in the employer's FICA contribution).

Thus the net energy cost increase, after the exemption, comes to 7.5 percent. When the reduced payroll costs are deducted from this, the average energy-intensive firm will experience the equivalent of a 6.2 percent increase in ener-

gy costs, with a range of 4.0 to 7.4 percent.

To offset this increase in costs, the average firm would have to improve its energy efficiency by 6.2 percent. Substantial evidence exists that virtually all industrial groups can cost-effectively improve their energy efficiencies such that they gain a net advantage from EEPRA. Studies also suggest that firms that improve their energy efficiencies achieve even greater financial savings from associated efficiency improvements (e.g. reduced disposal costs, reduced water usage, higher productivity and yields). Reductions in non-energy operation and maintenance expenses can outstrip energy savings by a factor of five or more.

Despite the attractive returns from investments in energy efficiency, most businesses have not taken full advantage of the potential savings in this area. There are several reasons for this.

• Except for a very few businesses, energy is not a large expense.

• Manufacturers are typically small firms with fewer than 20 employees. Their effort is focused on getting their product out the door.

• Businesses rarely invest in operational improvement measures that have paybacks longer than 1-2 years.

• Manufacturers, like all people, are resistant to change.

• Businesses have limited capital for reinvestment.

EEPRA helps to overcome these obstacles by offering carrots and a stick.

• The stick is that EEPRA will substantially increase energy costs.

• The carrot is that EEPRA offers up to a 75 percent reduction in energy taxes for firms that invest in all cost-effective efficiency improvements.

• Another carrot is that EEPRA offers $50 million to finance industrial audits and improvements.

• The fund will be disbursed by a Minnesota Efficiency Bank. The Efficiency Bank provides technical information as well as access to expertise.

• The Efficiency Bank provides capital on more attractive terms (lower rates, longer terms) than industry can obtain for its other needs.

• The Efficiency Bank can develop benchmarks for each industry and case studies of energy efficiency efforts for comparitive purposes.

The legislation is silent on how the Efficiency Bank appropriations are to be allocated or the location, function and structure of the Efficiency Bank itself. The best use of the money might be to set aside $5 million to pay for audits and the rest, aside from the necessary start-up and overhead financing, be used for financing efficiency improvements. The costs of the audits would be rolled into the efficiency improvement financing package and repaid from energy and operational cost savings.

The $5 million might pay for total assessment audits; that is, audits that analyze overall operational efficiencies, not just energy consumption, on approximately 250 plants. The $45 million could finance efficiency improvements on about 75 plants. This represents a significant portion of the needs of the most energy-intensive firms. However, if all the businesses in the state with energy costs over 2 percent of sales (the level at which a partial exemption begins) wanted to use EEPRA funds to invest in efficiency improvements, the capital requirements would exceed $1.9 billion. Therefore the state may need to identify sources of additional capital for efficiency financing.

Of all the industrial sectors examined, the iron ore (taconite) sector would be most burdened by EEPRA. Although efficiency improvements could offset part of the increased net tax impact

on this industry, another strategy might be designed specifically for this sector. This strategy would take advantage of the unique tax status of the taconite industry under Minnesota law. The industry currently pays a production tax on each ton of taconite produced. Thus an increase in production increases the tax paid in equal proportion. Substituting a carbon tax for the production tax allows the industry to pay a lower tax per ton if they reduce the energy used to mine a ton of ore.

EEPRA offers Minnesota not only a tool for reducing pollution and expanding the economy but a tool for improving productivity and lowering the operating costs of its industrial sector to make it more competitive with industries outside the state.

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Introduction

During the 1997 Minnesota legislative session the Economic Efficiency and Pollution Reduction Act (EEPRA) was introduced and debated. The legislation proposed restructuring Minnesota's tax system to achieve both economic and environmental goals.

EEPRA is a revenue-neutral and sector-neutral tax shift.

Revenue Neutrality The bill would not generate additional net income for the state. The $1.5 billion collected from the proposed $50-per-ton tax on carbon emissions from fossil fuel-based energy would be returned by reducing existing taxes by the same amount.

Sector Neutrality All additional taxes collected within a sector are returned to that sector. The business sector receives an approximate 21 percent reduction in their share of the FICA tax. The residential sector receives a per-household rebate of about $370.

However, the legislation is not revenue neutral within sectors. In the business sector, energy-intensive businesses will pay higher net taxes while energy-efficient businesses will pay lower net taxes on average. This is an expected and welcome outcome of EEPRA since the legislation is intended to encourage energy-intensive businesses to improve their efficiency. Nevertheless, if the new net tax burden is too great, it could impose a competitive burden on Minnesota firms.

Analyses at both the micro and the macro level found that a majority of Minnesota businesses would benefit from EEPRA. Two macro-economic analyses concluded that the state economy would benefit both in terms of expanded employment and a higher gross state product.[1] A study by the Tellus Institute found that EEPRA would result in a net production cost reduction for sectors representing 60 percent of the industrial output of the state.[2]

Case studies conducted by the Institute for Local Self-Reliance found that of 23 Minnesota businesses, most manufacturers benefited from EEPRA.[3]

Nevertheless, despite the evidence that the majority of businesses are winners under EEPRA, there are legitimate concerns that the tax shift could be burdensome to key Minnesota industrial sectors. This led the authors of the legislation to include two measures intended to minimize the impact on the industrial sector while achieving the same environmental goals.

•A conditional, partial tax exemption for energy-intensive firms.

The bill provides a sliding-scale reduction for energy-intensive firms. Firms with energy expenditures of less than 2 percent of sales are subject to the full carbon tax and earn the full payroll tax rebate. Those with energy bills of 2-3 percent of sales can receive a 25 percent exemption from the carbon tax and a 25 percent reduction on the FICA rebate A 50 percent exemption and reduction can be given to those firms with energy expenditures of 3-4 percent of sales, and a 75 percent exemption can be received by companies with energy bills greater than 4 percent of sales.[4]

The exemption is conditional on the firm's conducting an efficiency audit and investing in cost-effective measures. [5]

• Creation of an Efficiency Bank.

EEPRA appropriates $50 million to create an Efficiency Bank, which would provide technical expertise and low-interest, long-term loans for both audits and efficiency improvements.

This report evaluates the impact of EEPRA on Minnesota's most energy-intensive sectors and the potential for those sectors to increase their energy efficiencies and enjoy a net gain. The report also examines the possible role of an Efficiency Bank in reducing pollution and improving the efficiency of Minnesota's industrial sector.

Minnesota's Industrial Energy

Minnesota's industrial energy costs are in the lower half of the national range for gas and about average for electricity, except for the Minnesota Power service area, which has below average electricity rates.

Through a $50-per-ton tax on the carbon content of fuels, EEPRA would raise electricity rates by 1.3 - 1.5 cents per kWh and natural gas prices by $0.76 per Mcf. For the industrial sector this translates into about a 32 percent increase in electricity costs and a 26 percent increase in natural gas costs.

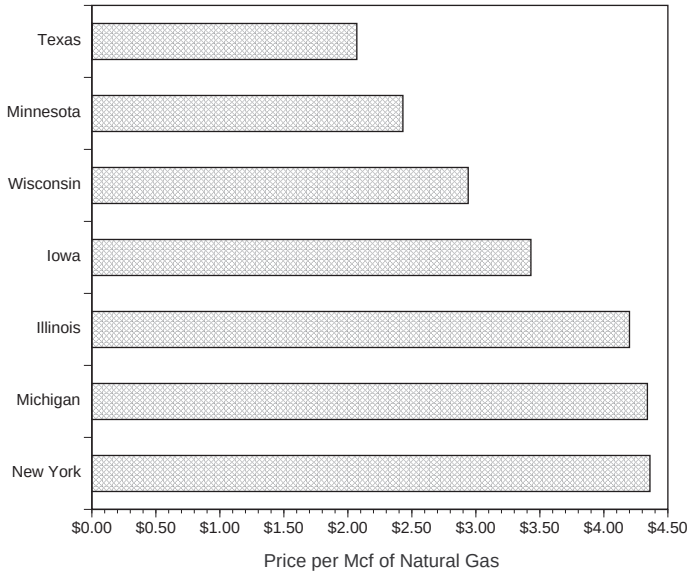
EEPRA's impact on operating costs will primarily be felt through the increased price of electricity because electricity accounts for about 83 percent of Minnesota's industrial firms' energy spending.

Figure 1: Ranking of Electricity Prices for Industrial Customers

Utility	State	Cents/kWh	Rank (out of 170)
Bonneville Power	Oregon	2.15	166
Wisconsin Public Service	Wisconsin	3.20	150
Interstate Power	Iowa	3.41	143
Minnesota Power	Minnesota	3.42	140
Otter Tail Power	Minnesota	4.14	94
Northern States Power	Minnesota	4.38	79
Commonwealth Edison	Illinois	5.79	33
Boston Edison	Massachusetts	8.88	8
Consolidated Edison	New York	10.92	3

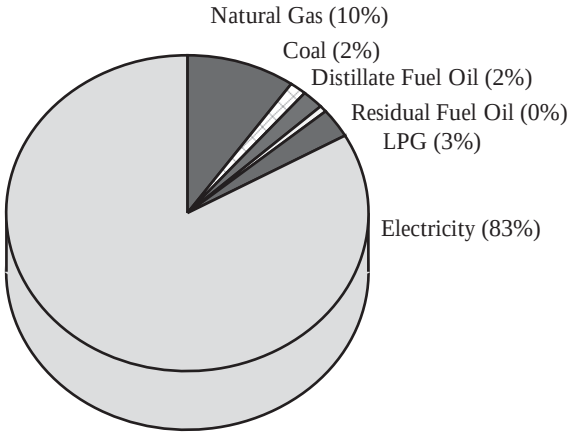
Source: *Energy User News*, March 1997. DOE Form EIA-826

Figure 2: Average Price of Natural Gas for the Industrial Sector



Source: *Energy User News*, March 1997, and DOE Natural Gas

Figure 3: 1993 Minnesota Industrial Energy Expenditures by Fuel Type



Source: *Minnesota Energy Data Book*, Minnesota Department of Public Service, February 1995

The Impact of EEPRA on Minnesota Industry

The Tellus Institute identified several sectors that would be adversely affected by EEPRA.[6] Table 1 and Charts 1 and 2 provide detailed information on these sectors.[7]

Table 1 provides information on the 37 most energy-intensive industries in Minnesota.[8] The iron ore industry is by far the most energy-intensive, with almost 25 percent of its sales revenues spent on energy, a total of some $37.88 million per site.[9] Almost all of the other energy-intensive industries spend 5 to 10 percent of their revenues on energy.

Thus, as we can see from Table 1, there are 25 iron and steel foundries in Minnesota. They spend on average 7.4 percent of their revenue on energy or about $410,000 per site. Paper mills spend about 8.2 percent of their revenue on energy and almost $7 million per plant.

Table 2 provides detailed information on the impact of EEPRA on Minnesota's industries. As noted above, EEPRA increases energy costs while decreasing payroll costs. It also provides for up to a 75 percent exemption from its net tax impact for energy intensive industries. All the industries in Table 1 would qualify for this level of exemption.

Column A of Table 2 shows the approximate increase in energy costs from EEPRA's $50-per-ton carbon tax, assuming a 75 percent exemption. Column C shows the decrease in payroll costs as a result of EEPRA's FICA tax rebate.[10] Column D subtracts Column C from Column A to calculate the net effect of the tax shift.

As we can see from column D, the taconite industry will experience an industrywide cost increase of about $18.8 million. The next highest industrywide total is for paper mills, with a cost hike of $5.1 million. The vast majority of industries see cost increases of less than $300,000, some individual firms see much smaller cost increases.

Column D estimates the net effect of the tax shift on each industrial sector. Dividing that number by that sector's overall energy expenditures from Table 1 gives us the percentage that energy consumption would have to decrease in order to offset EEPRA's impact. For example, Minnesota's 25 iron and steel foundries (SIC 3320) spent $10.20 million on energy in 1992 and would experience an increase in net costs of $560,000 as a result of EEPRA. They would need to improve their energy efficiency by about 5.4 percent to completely offset EEPRA's impact. Table 3 provides information on what level of efficiency improvement would be needed to offset EEPRA's additional tax burden.

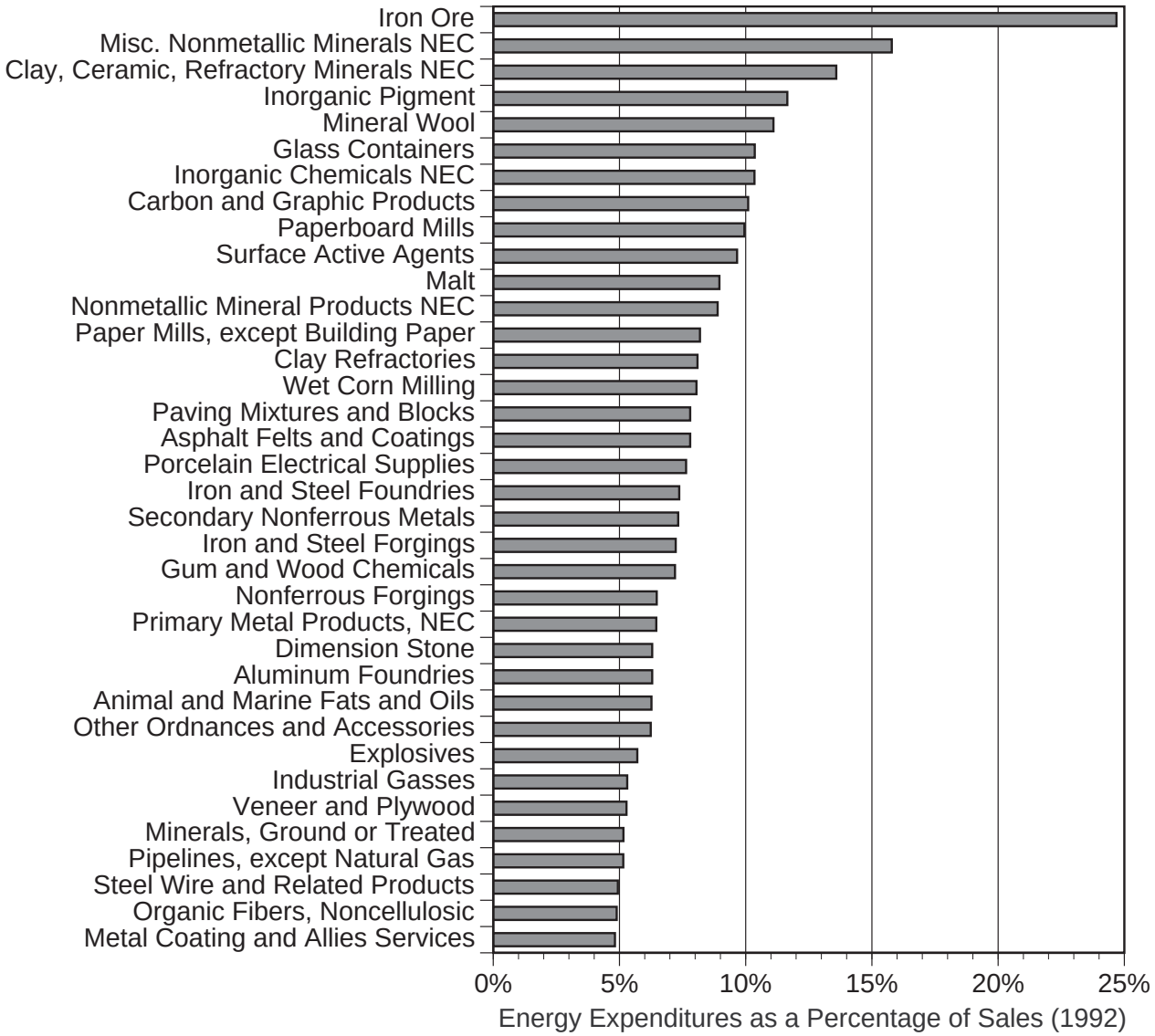
As we can see from Table 3, the efficiency improvements needed to offset EEPRA's net cost impact even for the most energy-intensive industries are quite modest. Indeed, this analysis might justify a lowering of the maximum exemption level to 50 percent from its currently proposed level of 75 percent. As Table 3 indicates, this would still require efficiency improvements of less than 14 percent for most industries in order to achieve a net gain from EEPRA.

Table 1: Minnesota's Most Energy-Intensive Industries

Industry	Column A Energy as % of Total Industry Output	Column B Energy Expenditures (million $ 1992)	Column C Total Industry Output (million $ 1992)	Column D Number of Minnesota Sites	Column E Avg. Energy Costs per Site (million $1992)
Iron Ore	24.69%	$265.16	$1074.05	7	$37.88
Misc. Nonmetallic Minerals NEC	15.79%	$1.71	$10.80	10	$0.17
Clay, Ceramic, Refractory Minerals NEC	13.59%	$0.35	$2.56	-	-
Inorganic Pigment	11.65%	$0.33	$2.87	3	$0.11
Mineral Wool	11.10%	$8.68	$78.23	5	$1.74
Glass Containers	10.36%	$5.57	$53.75	16	$0.35
Inorganic Chemicals NEC	10.35%	$3.60	$34.75	9	$0.40
Carbon and Graphic Products	10.10%	$0.11	$1.04	3	$0.04
Paperboard Mills	9.95%	$2.68	$26.92	-	-
Surface Active Agents	9.66%	$0.48	$4.99	4	$0.12
Malt	8.96%	$6.09	$67.97	14	$0.44
Nonmetallic Mineral Products NEC	8.89%	$0.49	$5.55	4	$0.12
Paper Mills, except Building Paper	8.19%	$83.01	$1013.80	12	$6.92
Clay Refractories	8.09%	$0.46	$5.71	1	$0.46
Wet Corn Milling	8.05%	$8.82	$109.48	7	$1.26
Paving Mixtures and Blocks	7.80%	$6.44	$82.59	12	$0.54
Asphalt Felts and Coatings	7.80%	$11.19	$143.46	5	$2.24
Porcelain Electrical Supplies	7.64%	$1.45	$19.03	2	$0.73
Iron and Steel Foundries	7.37%	$10.20	$138.29	25	$0.41
Glass and Glass Prod. except Containers	7.36%	$8.63	$117.29	6	$1.44
Secondary Nonferrous Metals	7.33%	$8.84	$120.63	8	$1.11
Iron and Steel Forgings	7.23%	$1.86	$25.68	5	$0.37
Gum and Wood Chemicals	7.20%	$0.42	$5.78	1	$0.42
Nonferrous Forgings	6.48%	$2.50	$38.60	2	$1.25
Primary Metal Products, NEC	6.46%	$0.44	$6.79	6	$0.07
Dimension Stone	6.30%	$4.65	$73.87	35	$0.13
Aluminum Foundries	6.30%	$12.47	$198.15	6	$0.40
Animal and Marine Fats and Oils	6.27%	$6.07	$96.87	9	$0.67
Other Ordnances and Accessories	6.24%	$20.84	$334.07	4	$5.21
Explosives	5.71%	$0.65	$11.46	3	$0.22
Industrial Gasses	5.31%	$0.46	$8.58	5	$0.09
Veneer and Plywood	5.28%	$3.29	$62.34	3	$1.10
Minerals, Ground or Treated	5.16%	$0.95	$18.49	3	$0.32
Pipelines, except Natural Gas	5.15%	$4.39	$85.31	39	$0.11
Steel Wire and Related Products	4.94%	$0.06	$1.25	4	$0.02
Organic Fibers, Noncellulosic	4.89%	$0.23	$4.75	2	$0.12
Metal Coating and Allies Services	4.82%	$6.20	$128.49	72	$0.09

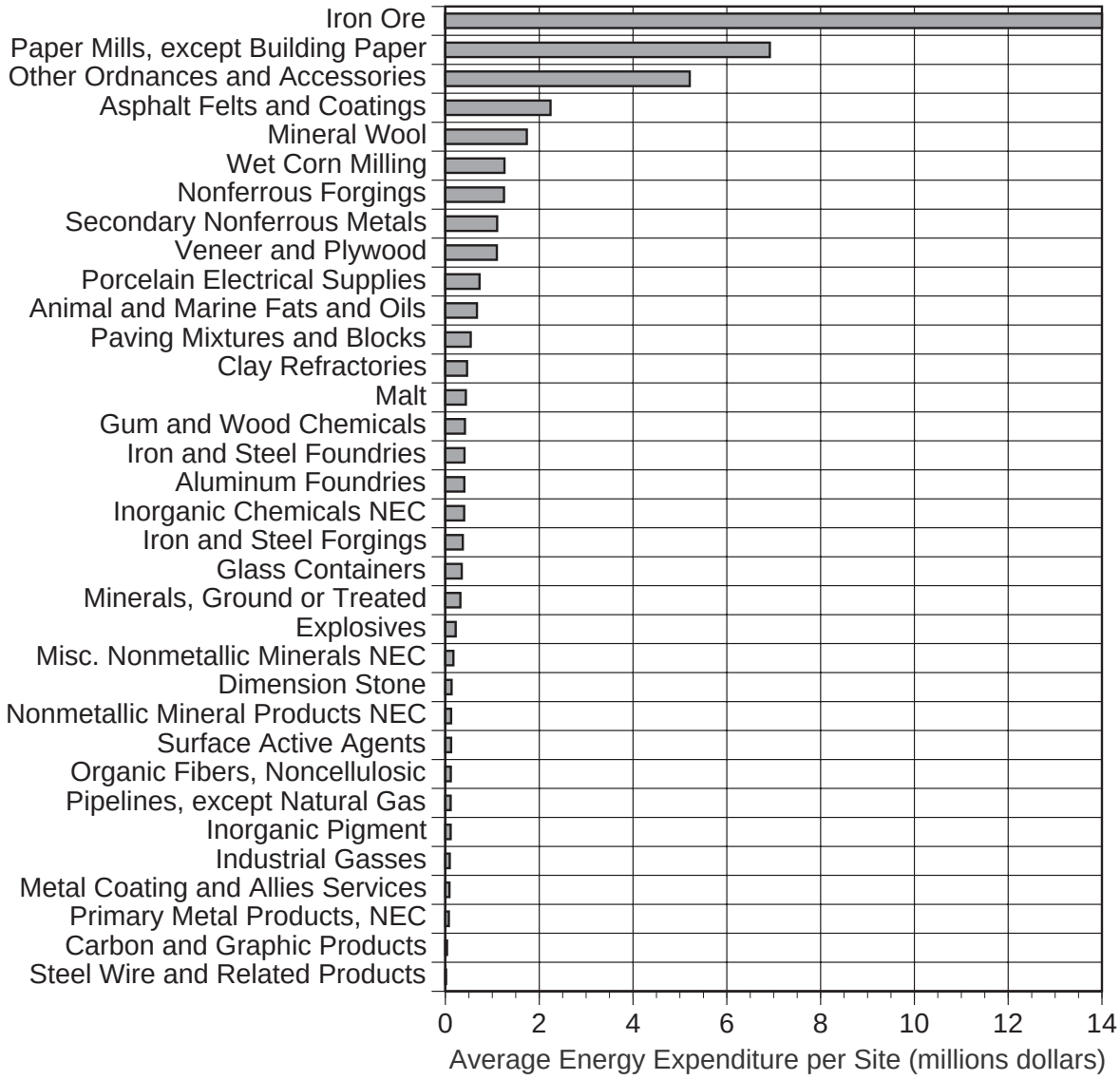
Source: Tellus Institute, *Carbon Taxes with Tax Reductions in Minnesota*, February 1997

Chart 1: Energy Expenditures as a Percentage of Sales by Industrial Sector



Source: Tellus Institute, *Carbon Taxes with Tax Reductions in Minnesota*, February 1997

Chart 2: Average Energy Expenditure per Site by Industrial Sector



Source: Tellus Institute, *Carbon Taxes with Tax Reductions in Minnesota*, February 1997

Table 2: Impact of EEPRA and Efficiency Improvements on Minnesota Industries

Industry	Column A Estimated Energy Cost Increase from EEPRA w/75% exemption ($ millions)	Column B Employee Compensation ($ million)	Column C Estimated Payroll Tax Reduction ($ million)	Column D Net Effect of Tax Shift with Exemption ($ million)
Iron Ore	$19.887	$268.257	$1.077	$18.810
Misc. Nonmetallic Minerals NEC	$0.128	$0.700	$0.003	$0.125
Clay, Ceramic, Refractory Minerals NEC	$0.026	$0.569	$0.002	$0.024
Inorganic Pigment	$0.025	$0.374	$0.002	$0.023
Mineral Wool	$0.651	$21.021	$0.084	$0.567
Glass Containers	$0.418	$15.622	$0.063	$0.355
Inorganic Chemicals NEC	$0.270	$8.355	$0.034	$0.236
Carbon and Graphic Products	$0.008	$0.284	$0.001	$0.007
Paperboard Mills	$0.201	$4.419	$0.018	$0.183
Surface Active Agents	$0.036	$0.481	$0.002	$0.034
Malt	$0.457	$7.598	$0.031	$0.426
Nonmetallic Mineral Products NEC	$0.037	$1.171	$0.005	$0.032
Paper Mills, except Building Paper	$6.226	$273.910	$1.100	$5.126
Clay Refractories	$0.035	$1.030	$0.004	$0.030
Wet Corn Milling	$0.661	$7.308	$0.029	$0.632
Paving Mixtures and Blocks	$0.483	$15.881	$0.064	$0.419
Asphalt Felts and Coatings	$0.839	$21.869	$0.088	$0.751
Porcelain Electrical Supplies	$0.109	$7.622	$0.031	$0.078
Iron and Steel Foundries	$0.765	$52.224	$0.210	$0.555
Glass and Glass Prod. except Containers	$0.647	$31.661	$0.127	$0.520
Secondary Nonferrous Metals	$0.663	$11.267	$0.045	$0.618
Iron and Steel Forgings	$0.139	$9.239	$0.037	$0.102
Gum and Wood Chemicals	$0.031	$0.730	$0.003	$0.029
Nonferrous Forgings	$0.188	$8.225	$0.033	$0.154
Primary Metal Products NEC	$0.033	$1.630	$0.007	$0.026
Dimension Stone	$0.349	$22.447	$0.090	$0.259
Aluminum Foundries	$0.936	$77.032	$0.309	$0.626
Animal and Marine Fats and Oils	$0.455	$11.144	$0.045	$0.410
Other Ordnances and Accessories	$1.563	$75.685	$0.304	$1.259
Explosives	$0.049	$4.861	$0.020	$0.029
Industrial Gasses	$0.034	$3.996	$0.016	$0.018
Veneer and Plywood	$0.247	$14.035	$0.056	$0.190
Minerals, Ground or Treated	$0.072	$5.588	$0.022	$0.049
Pipelines, except Natural Gas	$0.330	$11.312	$0.045	$0.284
Steel Wire and Related Products	$0.005	$0.141	$0.001	$0.004
Organic Fibers, Noncellulosic	$0.017	$1.210	$0.005	$0.012
Metal Coating and Allies Services	$0.465	$31.436	$0.126	$0.339

Table 3: Net Impact of EEPRA

Industry	Column A Energy Expenditures (million $ 1992)	Column B Energy Cost Increase w/75% Exemption ($ million)	Column C Net Impact of EEPRA w/75% Exemption ($ million)	Column D Percent Energy Savings to Offset EEPRA at 75%	Column E Percent Energy Savings to Offset EEPRA at 50%
Iron Ore	$265.160	$19.887	$18.810	7.09%	14.19%
Misc. Nonmetallic Minerals NEC	$1.710	$0.128	$0.125	7.34%	14.67%
Clay, Ceramic, Refractory Minerals NEC	$0.350	$0.026	$0.024	6.85%	13.69%
Inorganic Pigment	$0.330	$0.025	$0.023	7.04%	14.09%
Mineral Wool	$8.680	$0.651	$0.567	6.53%	13.05%
Glass Containers	$5.570	$0.418	$0.355	6.37%	12.75%
Inorganic Chemicals NEC	$3.600	$0.270	$0.236	6.57%	13.14%
Carbon and Graphic Products	$0.110	$0.008	$0.007	6.46%	12.93%
Paperboard Mills	$2.680	$0.201	$0.183	6.84%	13.68%
Surface Active Agents	$0.480	$0.036	$0.034	7.10%	14.20%
Malt	$6.090	$0.457	$0.426	7.00%	14.00%
Nonmetallic Mineral Products NEC	$0.490	$0.037	$0.032	6.54%	13.08%
Paper Mills, except Building Paper	$83.010	$6.226	$5.126	6.17%	12.35%
Clay Refractories	$0.460	$0.035	$0.030	6.60%	13.20%
Wet Corn Milling	$8.820	$0.662	$0.632	7.17%	14.33%
Paving Mixtures and Blocks	$6.440	$0.483	$0.419	6.51%	13.02%
Asphalt Felts and Coatings	$11.190	$0.839	$0.751	6.72%	13.43%
Porcelain Electrical Supplies	$1.450	$0.109	$0.078	5.39%	10.78%
Iron and Steel Foundries	$10.200	$0.765	$0.555	5.44%	10.89%
Glass and Glass Prod. except Containers	$8.630	$0.647	$0.520	6.03%	12.05%
Secondary Nonferrous Metals	$8.840	$0.663	$0.618	6.99%	13.98%
Iron and Steel Forgings	$1.860	$0.140	$0.102	5.51%	11.01%
Gum and Wood Chemicals	$0.420	$0.032	$0.029	6.80%	13.60%
Nonferrous Forgings	$2.500	$0.188	$0.154	6.18%	12.36%
Primary Metal Products, NEC	$0.440	$0.033	$0.026	6.01%	12.02%
Dimension Stone	$4.650	$0.349	$0.259	5.56%	11.12%
Aluminum Foundries	$12.470	$0.935	$0.626	5.02%	10.04%
Animal and Marine Fats and Oils	$6.070	$0.455	$0.410	6.76%	13.53%
Other Ordnances and Accessories	$20.840	$1.563	$1.259	6.04%	12.08%
Explosives	$0.650	$0.049	$0.029	4.50%	8.99%
Industrial Gasses	$0.460	$0.035	$0.018	4.01%	8.02%
Veneer and Plywood	$3.290	$0.247	$0.190	5.79%	11.57%
Minerals, Ground or Treated	$0.950	$0.071	$0.049	5.14%	10.28%
Pipelines, except Natural Gas	$4.390	$0.329	$0.284	6.47%	12.93%
Steel Wire and Related Products	$0.060	$0.005	$0.004	6.56%	13.11%
Organic Fibers, Noncellulosic	$0.230	$0.017	$0.012	5.39%	10.77%
Metal Coating and Allies Services	$6.200	$0.465	$0.339	5.46%	10.93%

Minnesota's Industrial Energy Savings Potential

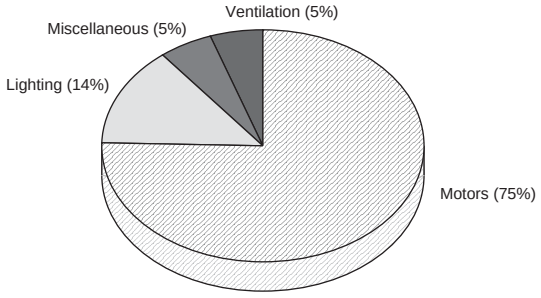
As a result of higher energy prices in the 1970s and 1980s, many industries have invested in energy efficiency. But they have captured only a fraction of the cost-effective potential savings.

According to industry efficiency experts, the average industrial customer could shave 10 percent off their energy bill with a simple audit and low cost changes to their operation.[11] Areas to focus attention on are lighting, motor systems and equipment maintenance and repair.

Motors

Over 80 percent of the energy used by Minnesota industries is in the form of electricity. And 75 percent of electricity is used to run motors. The percentage of electricity used for motors ranges from a low of 33 percent in primary metals to a high of 95 percent in pulp and paper manufacturing.[12]

Chart 3: Minnesota's Industrial Electrical Consumption By End-Use 1994



Source: *1996 Energy Policy and Conservation Report*, Minnesota Department of Public Service, December 1996

Neal Elliot of the American Council for an Energy-Efficient Economy (ACEEE) indicates that current motor systems could be replaced with a resulting 14-45 percent reduction in electricity use, with paybacks of 3-5 years.[13] The shortest term payback for such efficiency improvements occurs for large motors at the end of their useful life. The longest term payback occurs for small motors that have years of useful life remaining.

If motor systems in industry are not running at top efficiency this is an obvious area for investigation and investment. Only 5 percent of the motors in use are high efficiency, implying that motors are a ripe area for efficiency improvements.

Motor savings result both from choosing a high efficiency motor and carefully matching the motor to the job. Over-sizing motors results in below- design efficiency operation. New variable speed motor drives can benefit many manufacturing applications by not only improving energy efficiency but improving process control, leading to better product quality.

Motor use savings offers such a significant area for improvement that the Department of Energy (DOE) has started the Motor Challenge program. DOE is acting as a clearinghouse of information on energy-efficient motors. Software and case studies are available to help businesses make appropriate choices when designing production equipment and replacing motors. Locally, 3M has participated in the program and has staff available to advise area businesses about the program and motor efficiency.

Another area of savings from motors is compressed air systems. Compressors are run by large motors. Savings of up to 15 percent can be achieved by repairing the leaks in the distribution system so the compressor can run less frequently.[14] In addition, using multi-stage compressors reduces energy use by only powering enough stages to maintain air pressure at any given time.

Heat Recovery

Another area that can yield significant improvements in efficiency is heat recovery. Using waste heat to pre-heat raw materials is one method to improve efficiency. A second option is recovering the heat from waste water to pre-heat fresh water. Food processors use significant amounts of hot water and are only now starting to look at heat recovery strategies.

Sector Savings

Significant electricity savings can be found in all sectors of manufacturing. Table 4 is based on an analysis by industry experts hosted by the American Council for an Energy-Efficient Economy. If just half of the low savings potential were realized by Minnesota firms it would allow most to experience a positive impact from EEPRA.

Table 4: Electricity Conservation Potential Estimates

SIC	Industry	Low	High
33	Primary Metals	9%	30%
28	Chemicals	11%	44%
26	Paper	11%	49%
20	Food	16%	50%
37	Transportation Equipment	8%	32%
30	Rubber & Plastics	9%	37%
32	Stone, Clay & Glass	9%	37%
29	Petroleum & Coal	13%	56%
36	Electrical Equipment	10%	39%
34	Fabricated Metal Products	5%	20%
22	Textile	12%	42%
35	Industrial Machinery	7%	27%
24	Wood Products	10%	43%
27	Printing	11%	39%
38	Instruments	8%	32%
23	Apparel	11%	37%
25	Furniture	10%	35%
39	Misc. Manufacturing	8%	31%
21	Tobacco	12%	43%
31	Leather	12%	34%
	Average	**14%**	**38%**

Source: *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*, Neal Elliott, ACEEE, 1994

Case Studies

Foundry

There are 107 primary metals facilities in Minnesota. Industry experts estimate cost-effective energy savings for foundries at 15 to 45 percent.[15] Achieving one third the minimum energy savings potential would nearly offset the additional tax burden from EEPRA.

Savings opportunities include:

Furnace controls This equipment lets a foundry use more off-peak electricity for melting and provides more precise process control. New controls result in an average 10 percent savings on electricity.

Compressed air systems Repairing system leaks and upgrading drive motors are the best energy-saving projects for compressed air systems. Sources suggest a savings of at least 15 percent is possible.[16]

Project Examples

Florida Steel in Charlotte, North Carolina, is a minimill with a 75-ton Electric Arc Furnace (EAF).[17] They installed a scrap pre-heat line in 1989. The system uses waste gases from the furnace as well as a set of natural gas burners to pre-heat scrap as it moves down a conveyor towards the furnace. This system reduced energy use by 6.9 percent.[18] Scrap pre-heating

would improve efficiency in most foundry operations, not just EAF operations.

The Energy Foundation has done a case study with the Chris Erhart Foundry and Machine Company in Cincinnati, Ohio. The company installed a computer control system for its 800 kilowatt induction furnace and reduced demand by 182 kilowatts per month, a 23 percent savings. The controller also allowed it to use more off-peak electricity. The system saved the firm $22,000 per year with a 6-month payback.[19] This change shaved 4 percent off their operating cost.

Crane Valves has a foundry in Washington, Iowa, that was experiencing business problems and sought assistance. Six different groups were called in for audits on their entire system, including productivity, quality, waste and energy use. Crane was able to reduce electricity use per ton of iron poured by 29 percent. The changes in operation turned them into the best performing facility in their company. They now produce 225 percent more material per day, but their energy use rose only 60 percent.[20]

Metal Finishing

There are approximately 72 facilities operating in Minnesota in the metal coating and allied services sector (SIC 3479). Areas for savings in metal finishing include ventilation, motor upgrades, waste reduction and process heat recovery.

Project Examples

Lockheed Martin Armament Systems Division examined the ventilation system in their industrial plating plant in Burlington, Vermont, a large operation with 9 plating lines. They designed a new ventilation system that uses variable speed drives and an advanced control system. The control system can sense if a production line is in use and adjust the ventilation rate accordingly. An investment of $100,000 earned the following returns:

Electric Savings	443,332 kWh
	$35,700/year
Natural Gas Savings	17,840 therms
	$26,500/year

The above changes resulted in a 38 percent reduction in electric and natural gas bills. The payback was 1.4 years.[21]

The Industrial Technology Institute (ITI) recently completed a survey of metal finishers to benchmark industry practices in several areas including energy use and pollution prevention. They discovered a wide range of efficiencies even within profitable firms. For example, the best firm used only 36,000 gallons of rinse water per $100,000 in sales, although the median for all firms surveyed was 213,000 gallons. Energy costs as a percent of sales for the median firm was 5.0 percent (very much in line with the 4.8 percent for metal finishing firms listed in Table 1). The best firms had energy costs as low as 1.2 percent of sales. Thus the most efficient firms used almost 80 percent less energy per unit of sales than the median firm.

Paper

Paper and pulp is the second most energy-intensive industry in the United States. The Amercian Council for an Energy-Efficient Economy brought together industry experts who concluded that a reduction of 20 percent in steam use and 15 percent in electricity could be achieved with currently available technology.[22]

Twelve paper mills are operating in Minnesota. Each spends about $7 million a year on energy. The majority of the mills are in northern Minnesota. Several are served electricity by Minnesota Power. These companies have been able to take advantage of the Industrial Conservation Project (ICP) and Large Power Incentives Program (LPIP) to implement efficiency improvements.

Blandin Paper invested $1.3 million in one project and gained $1.2 million in savings the first

year, not all from electircity savings. Electricity consumption fell by 1.4 percent and electricity demand by 1.5 percent. A second Blandin efficiency investment of $2.1 million reduced energy and water treatment costs by more than $1.8 million and saved an additional 0.5 percent in electricity and 0.5 percent in electricity demand. Combined, the Blandin projects saved more than 2 percent of its energy demand.

Lake Superior Paper Industries recently invested $2.1 million to upgrade its steam system. The investment resulted in significant energy savings, and an overall $1.3 million savings in annual operation and maintenance costs.[23]

Food Processing

There are approximately 716 food processing facilities in Minnesota. The margin on food production is small, making any efficiency improvements significant to a company's survival and growth.

In the food processing industry 87 percent of energy used is for motors. Refrigeration compressors are a significant portion of the motor load and a good area for efficiency improvements. There is also significant potential for energy savings by extracting heat from waste water to preheat fresh water.

Mar-Jac Inc. processes poultry in Gainesville, Georgia.[24] They use significant quantities of hot water, between 120° and 130°F. They replaced three old natural gas-fired boilers with 2 water heaters and a direct-fired gas water heater. The new equipment supplies water at 180° F, a process improvement. The system cost $210,000 to install and saves them 40 percent on their natural gas bill. They save over $70,000 annually, resulting in a 3- year payback.[25]

Associated Savings from Energy Efficiency Improvements

In most cases businesses that invest in energy efficiency improvements achieve impressive reductions in other operating costs. A lighting upgrade can reduce maintenance costs. An improvement in industrial processes can reduce not only energy consumption but solid waste, while increasing yield.

Lake Superior Paper Industries' steam upgrade, which cost about $2 million, produced energy savings of only $136,000 a year. However, it also reduced operating and maintenance costs by over $1.2 million a year.

National's taconite mine in northern Minnesota upgraded their compressed air system, investing $420,000 and saving $32,000 a year on energy. Operation and maintenance savings were $107,000, well above the energy savings.

Along with its significant energy savings, the Crane Valve foundry in Iowa achieved a 29 percent reduction in scrap and a 27 percent improvement in yield.

Since 1981 Dow Chemical Company has had an energy conservation program in its Louisiana Division. Employee suggestions are reviewed and implemented if they meet the selection criteria: a) a capital cost under $200,000, and b) a return on investment (ROI) of 100 percent (one year payback). Table 5 shows that over the years Dow Chemical has received an increasing proportion of its energy savings from productivity improvements.

Table 5: Dow Chemical Summary

		1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Improvement Cost (mil $)		1.7	2.2	4.0	7.1	7.1	10.6	9.3	7.5	13.1	8.6	6.4	9.1
Savings (million $)	Fuel Gas	2.97	7.65	6.90	7.53	7.14	5.53	4.17	3.05	5.11	2.11	5.17	4.59
	Yield & Cap.	0.08	-0.06	1.51	2.50	0.80	3.75	13.37	32.74	8.66	17.91	11.65	20.31
	Maint.	0.01	0.05	-0.06	0.19	0.36	2.21	0.58	1.12	1.68	2.36	2.95	2.76
	Misc.	0.00	0.00	0.00	0.00	0.00	0.02	-0.10	0.15	2.13	5.27	0.52	0.79
Total Annual Savings		3.06	7.63	8.35	10.22	8.29	11.50	18.02	37.06	17.58	27.65	20.28	28.44

Source: Elliott, Neal. *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector,* ACEEE,

Maximizing Efficiency

As we have seen, even among Minnesota's most energy-intensive industries, the net adverse impact of EEPRA is modest and can be offset by a modest improvement in energy efficiency. Experts estimate that cost-effective energy efficiency savings can range from 5 percent to as high as 55 percent using proven technologies.[26] And the byproduct savings from investments in energy efficiency often are several times greater than the savings from energy reduction alone.

Given this information, one might wonder why industries have not invested in all energy efficiency improvements. Several factors account for the gap between the potential and the reality.

- Manufacturers are typically small operations with fewer than 20 employees. They do not have the time or staff expertise to address efficiency issues. Their focus is on getting the product out the door.
- Energy is not a large expense for most businesses. A typical manufacturer spends less than 1 percent of revenues on energy. The dollar savings do not appear attractive enough to motivate management to focus on energy.
- Businesses rarely invest in operational improvement measures that have paybacks longer than 1-2 years. Meeting this standard significantly reduces the amount of energy they can save. Minnesota's inexpensive energy lengthens the payback period for efficiency investments.
- Manufacturers, like all people, are resistant to change. They don't tend to try new technologies or methodologies, especially when they don't perceive a very big "upside potential". "If it ain't broke, don't fix it."
- Businesses have limited capital for reinvestment. When capital is available, efficiency projects must compete with other possible capital expenditures within the company. Usually capital expenditures that increase sales or expand product lines are favored over process improvements.

EEPRA provides both a carrot and a stick to overcome these obstacles.

- Manufacturers will see their energy costs increase an average of 30 percent with the EEPRA legislation. This makes efficiency investments more attractive.
- Energy-intensive companies are required to invest in cost-effective efficiency improvements to qualify for the substantial tax exemption. This provides the stick to the Efficiency Bank's financial and technical assistance carrots.
- The Efficiency Bank provides technical information as well as access to expertise for audits, data analysis and design work. This removes the burden from over-extended manufacturing personnel. In addition, the plant personnell could be trained in efficiency so they could make ongoing improvements.
- The Efficiency Bank can assist industries in developing benchmark studies so that individual firms can compare their operational efficiencies to other firms in the same sector, a practice that tends to encourage the less efficient firms to improve their operational competitiveness.
- If the Efficiency Bank finances total assessment audits, associated savings in non-energy areas can dwarf the energy savings. The total improvements in yield, disposal costs, pollution monitoring costs as well as energy costs should make efficiency investments more attractive to the manufacturers.

A Minnesota Efficiency Bank

Although EEPRA provides for the creation of an Efficiency Bank, it does not clarify what that bank would do, how it would function, or what the criteria for investments would be. Below are some recommendations.

Total Assessment Audits

A total assessment audit examines not only energy savings potential but also waste reduction, pollution prevention and productivity improvements. Due to the complexity of some manufacturing processes, this type of audit can require a team of experts to examine the process and facility in order to identify opportunities for savings. By looking holistically at a manufacturing operation the recommended changes to one area will not adversely affect another area, but rather they will complement each other, resulting in even greater savings.

Audits can identify cost-effective efficiency measures for the company. In many cases energy savings after improvements represent only a fraction of the total savings. The largest impacts on the bottom line typically come from productivity improvements. These productivity improvements represent a modernization of the manufacturing base in the state.

While there are many excellent engineering firms and industry experts in the state, none to our knowledge are currently doing total assessment audits. The expertise does exist in the state to do the work, but new partnerships and work practices would need to be developed to meet the needs of industrial audits. The Industrial Technology Institute in Michigan and the Iowa Energy Center are developing training materials so they will be able to offer workshops on total assessment audits. Appendix A contains a list of some companies who would be capable of developing auditing programs.

What is Cost Effective?

EEPRA uses the term "cost effective" but does not define it. As noted above, businesses rarely invest in energy efficiency improvements that have paybacks of longer than two years and often require one year paybacks. The Efficiency Bank's objective is not to maximize the return on the efficiency investment but rather to maximize the reduction in energy use and pollution. Given the source of the funds (e.g. direct appropriations or government bonds), the Efficiency Bank can provide relatively low interest (e.g. 7 percent) loans for projects with relatively long payback periods (e.g. 7 years). The combination of low interest rates and long payback periods would allow the Bank to maximize energy-efficiency improvements.

Audit Program Case Studies

Minnesota can learn from the fledgling efforts in other states and from industrial energy efficiency efforts at the national level. For example, the federal government has started educational and demonstration programs in the steel and glass industries.[27]

Minnesota Power

One experience in industrial audits close to home is the Industrial Conservation Project (ICP) of Minnesota Power.[28] In some respects the carrot and stick approach used by EEPRA is similar to the ICP approach. In that instance, state law requires electric utilities to invest 1.5 percent of their revenues in conservation programs. For large industrial customers, Minnesota Power set aside the entire 1.5 percent of their electricity expenditures into a separate conservation fund. In effect, the ICP became a forced energy conservation savings fund. Similarly, EEPRA provides for a significant tax exemption so long as the company invests in

cost-effective energy efficiency improvements. In essence, EEPRA is channeling part of the tax increase into a conservation fund for qualifying firms.

Michigan

The Michigan Energy and Environment Center performs industrial audits. Two programs target different-sized manufacturers. The Energy Cost Reduction Program focuses on manufacturers with facilities of 25,000 to 75,000 square feet. These audits typically cost $3,000 to $5,000. Energy savings average 12 percent. The Manufacturing Energy Analysis Program targets manufacturers with facilities of 75,000 to 300,000 square feet. These audits cost $6,000 to $13,000. The average energy savings for this group has been 17 to 20 percent. The majority of the improvements made as a result of the audit have paybacks of under three years.

Iowa

The Iowa Energy Center is currently coordinating five total assessment audits in five different industrial sectors: metal casting, metal fabricating, plastics, food processing and printing. These audits are being completed as case studies to demonstrate the value and transferability of the total assessment audit methodology across the industrial sector. The audits should be completed in the fall of 1998, although some will be completed this winter (97/98). The center uses locally available experts from different technical assistance programs in the state, including DOE's Industrial Assessment group at Iowa State University and the community college's Manufacturing Extension Technology experts. The Iowa Energy Center is also designing a training program to transfer their methodology to other organizations or private groups.

Ohio and Michigan

The Cleveland Advanced Manufacturing Program (CAMP) in Ohio and the Industrial Technology Institute (ITI) in Michigan have developed a methodology and assessment tools for industrial audits with funding from the Department of Energy. They have targeted particular industries: metal finishing, metal forming and screw machine parts. They are conducting trainings for auditors throughout the United States at this time. They are benchmarking industries to develop references for future audits.

The Ohio Energy Office has a new program that loans up to $40,000 to manufacturers to pay for industrial audits. From $15,000 to $20,000 of the loan is used for the audit. The balance pays for engineering design work to implement the changes recommended by the audit. This pilot program has $240,000 to loan at this time. If the program stimulates sufficient interest, a $5 million pool will become available next year. Money for the program is from oil overcharge payments to the state.

Financing

The EEPRA legislation appropriates $50 million for an Efficiency Bank. There is no breakdown on how that money would be allocated.

A reasonable allocation would be to set aside $5 million to finance total assessment audits. Audits vary in cost depending on the size of the facility and manufacturing processes involved. The list on Table 1 shows about 370 adversely affected sites.

Small facilities with relatively simple operations can receive a complete audit for as little as $3,000. In contrast, Minnesota Power has done audits of its large industrial power customers that cost an average $114,000. An audit pool of $5 million could finance about 250 audits.[29]

The cost of the audit could be rolled into the overall efficiency loan and be paid back from energy savings.

The remaining amount from the appropriation for the Efficiency Bank is $45 million. Part of this would be required for start-up and overhead. The money remaining after these expenses would make up the Efficiency Bank's improve-

ment loan pool. We envision the Efficiency Bank initially being part of a state agency, probably the Department of Trade and Economic Development although it could eventually become a free-standing entity.

If all the businesses on Table 1 invested in projects that saved 7 percent of their energy costs with paybacks of 5 years, the capital investment needed would be about $305 million.[30] If the payback were lengthened to 7-years the investment needed would be $428 million. If all the businesses in Minnesota with energy costs over 2 percent invested as above, with a 7 year payback, the total capital needed would be $1,971 million. To attract this additional investment the Efficiency Bank would act as an educator for banks and other funding sources to increase their participation in loans of this nature. The Efficiency Bank would reassure them that these types of loans are not only safe but offer an avenue to boost the economic strength of a business and lead to long-term growth.

It should be noted that under EEPRA, businesses that want to qualify for the partial tax exemption would have to guarantee that they would invest in all cost-effective efficiency improvements by the fifth year. Thus we can expect that the audits and efficiency investments will be spread out over several years, and a portion of the $50 million appropriation will be returning in the form of loan repayments and will be available for further financing.

The Efficiency Bank would also serve as an information source for other efficiency financing options. The Efficiency Bank could refer the manufacturer to a list of qualified Energy Service Companies (ESCOs) that are willing to work in the specific region or industry. Many ESCOs complete all aspects of the project from initial audit to final implementation and monitoring. The ESCO is paid over time from guaranteed energy savings and productivity improvements. At this time there are relatively few ESCOs working on industrial projects, but if demand rises they could diversify into the industrial arena.

The Special Case of Iron Ore

Seven iron ore mines operate in Minnesota. Their energy costs are 24.7 percent of their total industrial output, by far the highest in the state. The taconite industry would be hard hit by EEPRA. The industry has the potential for improving efficiency, as was evident by the results from Minnesota Power's ICP program.

In that program the Eveleth Mine invested $1 million and achieved operating and maintenance savings of $600,000 and reduced its energy bill by 1.7 percent. The Hibbing Main Mine also invested $1 million and shaved 0.7 percent off its electric bill. Interestingly, while the Hibbing mine had operational and maintenance savings of only $135,000, it also increased production capacity by 70,000 long tons, a 7.9 percent increase for that line and worth $2,800,000.

These are substantial savings, but they are not in the range needed to offset the net impact of EEPRA on the taconite industry.

In order not to unduly burden the taconite industry yet be consistent with the environmental goals of EEPRA, the legislature might consider exempting the taconite industry from EEPRA while replacing the existing production tax on taconite with a carbon tax.

The $50-per-ton tax on carbon imposed by the EEPRA legislation would increase the tax burden on the taconite industry by about $20 million. In 1996 the mining companies paid over $104 million in production taxes. A $260-per-ton carbon tax on the taconite industry would generate the same amount of money as the current production tax. But the carbon tax would reward efficiency while the production tax does not. The current tax increases proportionately to the number of tons produced. Double the output and the total taxes paid doubles. With a carbon tax, the tax rises not with production but with pollution, and if the industry can expand production while moderating pollution it pays a smaller tax per ton.

Endnotes

1 Backus, George, *Minnesota Tax Shift, Performance Assessment*, Denver, CO, 1996. Steve Bernow, Mark Fulmer and Irene Peters, *Carbon Taxes with Tax Reductions*, Tellus Institute, Boston, MA, January 1997.

2 The Tellus report did not take into account the impact of the partial tax exemption of EEPRA, which would undoubtedly have substantially increased this percentage.

3 Morris, David, Alyson Schiller and John Bailey, *The Minnesota Ecological Tax Shift: Impact Analysis on Individual Businesses*, Institute for Local Self-Reliance, Minneapolis, MN, 1997.

4 The bill as written has step gradients for the exemption. This presents a problem because one company that spends 4 percent of its revenues on energy will gain a 75 percent exemption while a company that spends 3.9 percent will have an exempt of only 50 percent. This gives a competitive edge to the more energy-intensive firm, a perverse incentive given the goal of the bill. One might expect that the final bill will contain a smooth gradient resulting in a continuous slope exemption.

5 The firm must make these investments within five years of its request for an exemption. EEPRA allows the company to perform an in-house audit or to use the services of independent auditors. Cost-effective is not defined by the legislation.

6 Data is from Bernow, Steve, Mark Fulmer and Irene Peters, *Carbon Taxes with Tax Reductions*, Tellus Institute, Boston, MA, January 1997. Not all 50 sectors are listed because not all are currently represented in the state. Also note that these are not all the energy-intensive business sectors in the state. For instance the fertilizer, carbon & graphite products and adhesives & sealant sectors are energy-intensive, but receive enough benefit from the employment tax rebate to not be on the most adversely affected list.

7 The Clay, Ceramic and Refractory Minerals NEC (Not Elsewhere Classified) do not have a site count due to confidentiality issues.

8 The industries included are those most affected by the EEPRA legislation as determined by the Tellus Institute research.

9 The state of Minnesota Department of Commerce supplies information on the number of sites for each industry but this doesn't always mean the number of plants because in some instances the headquarters plant which is largely administrative may be considered a site. Thus the date on the number of sites and the energy expenditure per site in Table 1 should be viewed as illustrative, not precise.

10 The FICA rebate is estimated by multiplying the compensation x 7.65% (employers contribution) x 21% (estimated reduction from the EEPRA legislation) x 25% (the amount received under the 75% exemption case for these companies).

11 Private Conversations with Ron Rich of Pollution Prevention Technologies, Bill Poppert of Technology North, June Wheeler of Herzog /Wheeler and Associates. All are Minnesota engineering consultants.

12 Elliott, Neal, *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*, ACEEE April 1994.

13 *Ibid.*

14 *Ibld.*

15 The primary metals industry is a Department of Energy Industry for the Future. It is their research supporting the 15 to 45 percent reduction potential.

16 Elliott, Neal, *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*, ACEEE April 1994.

17 *Ibid*.

18 Energy costs in North Carolina are comparable to Minnesota.

19 The energy costs in Ohio are comparable to Minnesota's.

20 Crane went from using 32,736 kWh/day to 52,344 kWh/day but increased their production from 32 tons/day to 72 tons/day.

21 The energy costs in Minnesota are about half those in Vermont, which extends the payback to 3 years.

22 Nilsson, Lars J., Eric D. Larson, Kenneth R. Gilbreath, and Ashok Gupta, *Energy Efficiency and the Pulp and Paper Industry*,

ACEEE, September 1995.

23 Lake Superior Paper did not invest the entire $2.1 million, but received a portion of the capital from the ICP project.

24 *Boosting Prosperity: Reducing the Threat of Global Climate Change through Sustainable Energy Investment*, Energy Foundation, 1996. Minnesota has 28 poultry processing sites where similar projects could be implemented.

25 Natural gas in Georgia is only slightly higher priced than Minnesota, leaving the payback within the criteria for an Efficiency Bank project.

26 Elliott, Neal, *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*, ACEEE April 1994.

27 The Department of Energy has started an Industries of the Future program. The program targets seven energy intensive sectors for research and education about new technologies which will help them remain competitive. The seven industries are: steel, aluminum, metal casting, glass, chemicals, forest products, and petroleum refining. A partnership in agriculture is currently being formed.

28 *1996 Conservation Improvement Program Consolidated Filing*, Minnesota Power, March 31, 1997.

29 If all audits cost $114,000 then 43 can be done with the loan pool. If all audits cost $3,000 then 1600 could be funded. The industrial average is $20,000 per audit, resulting in the $5 million funding 250 audits.

30 The energy use of the sectors represented on Table 1 is $873 million. If they save 7%, $61 million, with a 5 year payback, the total investment needed is 5 x $61 million = $305 million. It is assumed that the investments would be rolled out over several years. Our suggestion is for paybacks of 7 years defined as economical for the Efficiency Bank loan criteria. Businesses with energy costs over 2% of sales spend $4,023 million on energy. 7% savings with 7 year payback means the investment needs to be $4,023 million x 7% x 7 years = $1,971 million.

Appendix A

Technical Resources in Minnesota

A & S Enercom
Advanced Energy Services Inc.
Alternative Energy Management Inc.
Barr Engineering
Boss Aire
The Brauer Group
Cenerprise Inc.
Center for Energy and Environment
Climate Makers Inc.
CES - Commercial Energy Services
Control Products
DanMar and Associates
Dectra Corp.
Delta Light
Direct Digital Controls
EER Products
The Energy Conservatory Inc.
Energy Profiles
Energy Research and Consulting
Energy Solutions International Inc.
ENTAC
Environment and Energy Resource Center
GA Ernst and Associates
Gada And Associates
Herzog/Wheeler and Associates
Honeywell
Intelligent Lighting Controls Inc.
Johnson Controls
RC Lambert and Associates
Mammoth Inc.
Metro Electric
Michaud Cooley Erickson Consulting Engineers
Minnesota Cold Weather Resource Center
Minnesota Manufacturing Technology Center
Minnesota Technical Assistance Program
Mitor Industries Inc.
MultiVest Ltd.
Northwest Lighting Systems Company
Pollution Prevention Technology
PSA Consulting
Premier Lighting Inc.
RCD Corp.
St. Paul Neighborhood Energy Consortium
Schedin and Associates
Sebesta Blomberg and Associates
Sustainable Resources Center
Technology North
Terra Resources Inc.
Trane
Waste Reduction Institute for Training and Application Research
XeteX Inc.

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