Market Assessment Summary of Energy Savings Opportunities

Opportunities for Industrial Motor Systems in the Pacific Northwest

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*report #*99-044

December 1999

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ASSESSMENT OF INDUSTRIAL MOTOR SYSTEMS MARKET OPPORTUNITIES IN THE PACIFIC NORTHWEST

Prepared for The Northwest Energy Efficiency Alliance

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October 1999

2. Summary of Energy Savings Opportunities

2.1 Motor Energy Use by Sector.

The motor energy consumption in the PNW is concentrated in a handful of large motor energy-using sectors. There are 11 that together consume most (over 90%) of the motor and motor systems energy in the PNW. Three of these – Pulp and Paper, Irrigation, and Chemicals – together consume over 50%. (Chart A)

- The Pulp and Paper industry in the PNW is the largest consumer of motor energy (25 %). The industry in the region is a significant 10% of the national output, but includes a disproportionately large share of the basic pulp production, a very large consumer of motor energy.

- Irrigation systems are the second largest consumer of motor energy (15.5 %). About 24,000 farms in western Washington and Oregon and in Idaho use ground water for crop irrigation drawn by deep well pumps, most driven by motors.

- Even though the PNW does not have a large share of the U.S. chemical industry, because this industry, by the nature of its processes, is such a major user of motor energy this industry accounts for an estimated 10.5% of the region's motor energy use.

Other sectors that are major consumers of motor energy include:

- Mining – motor energy for pumps, fans and compressors, and lift equipment.

- Food and kindred products – refrigeration a major user of energy.

- Lumber and wood products – wood moving and processing.

- Water and wastewater – pumping and waste aeration.

- Petroleum and coal products – a small number of refineries, but each a major consumer.

2.2 Motor Energy Use by Application.

The three common types of equipment – pumps, fans, and air compressors, use approximately 60% of motor systems energy. (Table A.) The large number of pump systems is a product of the pulp mills that move huge amounts of liquid and slurry, and the irrigation of agricultural land. The 40% driving other types of equipment includes prominently – refrigeration compressors, materials handling in paper, wood products and general machinery drives in many industries.

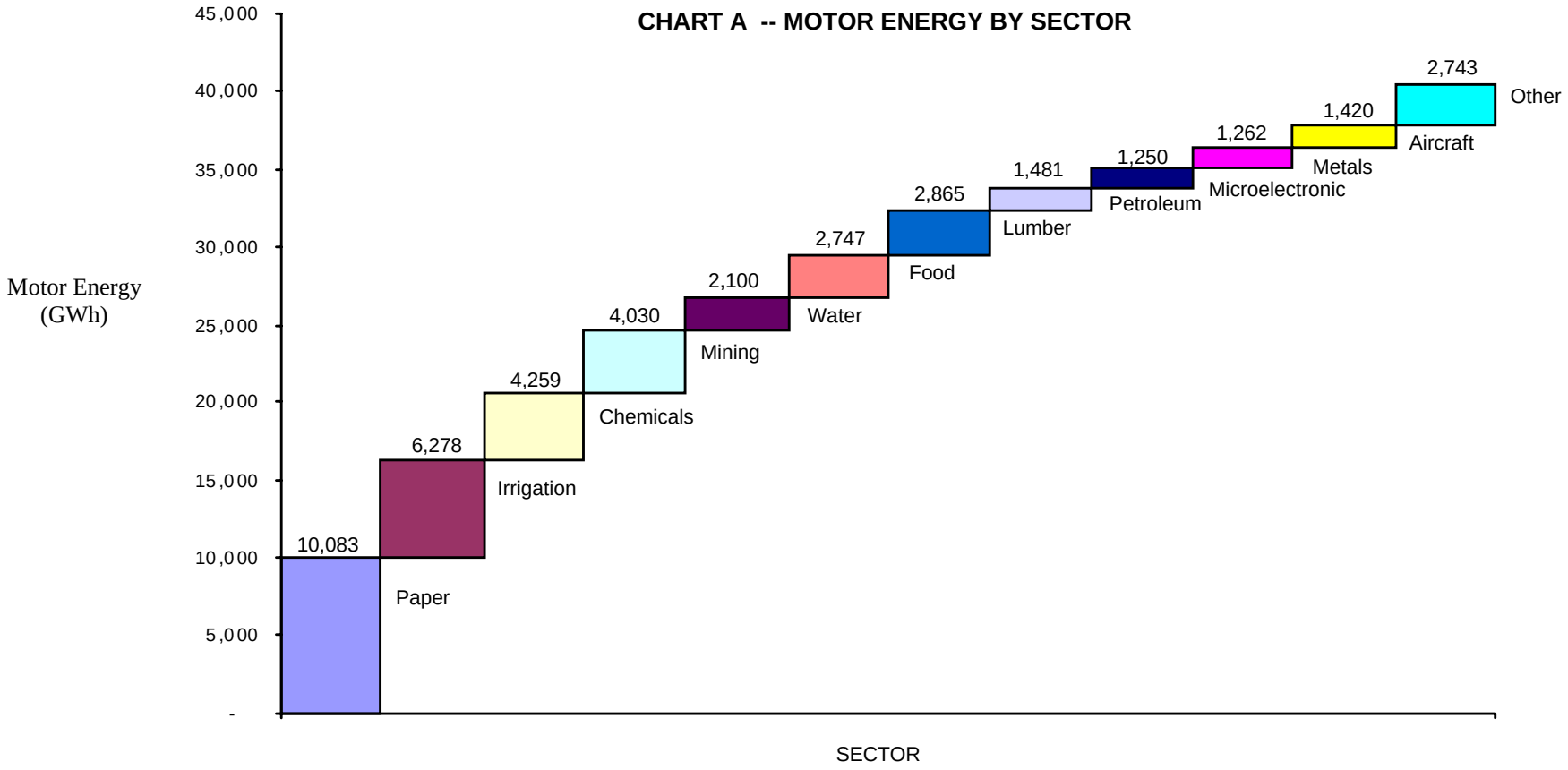
CHART A -- MOTOR ENERGY BY SECTOR
Motor Energy (GWh)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
10,083
Paper
6,278
Irrigation
4,259
Chemicals
4,030
Mining
2,100
Water
2,747
Food
2,865
Lumber
1,481
Petroleum
1,250
Microelectronic
1,262
Metals
1,420
Aircraft
2,743
Other
SECTOR

TABLE A

Motor Energy Use by Sector and Equipment Type

	Pumps		Fans		Air Compressors		Other		Total
Sector	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**
Paper and Pulp and Allied Products	3,170	31%	1,993	20%	460	5%	4,462	44%	10,084
Irrigation	6,278	100%	-	0%	-	0%	-	0%	6,278
Chemicals and Allied Products	1,109	26%	505	12%	1,179	28%	1,466	34%	4,259
Mining	322	8%	967	24%	161	4%	2,579	64%	4,030
Water Supply and Wastewater Treatment	966	46%	151	7%	834	40%	149	7%	2,100
Food and Kindred Products	451	16%	208	8%	212	8%	1,877	68%	2,748
Lumber and Wood Products	151	5%	348	12%	237	8%	2,132	74%	2,867
Petroleum and Coal	873	59%	141	10%	226	15%	240	16%	1,480
Microelectronics	250	20%	625	50%	250	20%	125	10%	1,249
Primary Metals	110	9%	192	15%	182	14%	778	62%	1,262
Aircraft and Parts	265	19%	309	22%	265	19%	582	41%	1,421
Other	308	11%	392	14%	484	18%	1,560	57%	2,744
Total	14,252	35%	5,830	14%	4,489	11%	15,950	39%	40,522
Average MW	1,625		665		512		1,818		4,620

2.3 Motor Energy Saving

The estimates of the opportunities for motor energy savings have been based on the extensive work done for the DOE Motor Challenge in its report "United States Industrial Electric Motor Systems Market Opportunities Assessment." This savings method measures the energy savings that are achievable using existing technology and they are economically justified using typical industrial return on investment calculations. It essentially considers saving potential as being based on – economically justified retrofit (not plant redesign) of equipment, a three-year payback hurdle calculation, and considers the extent to which the industry as a whole has already made investment in energy saving.

We also have used the seven classifications of types of motor savings as the basis of the report, these are:

- Motor Efficiency Upgrade – the savings potential of moving from pre-EPAct motor efficiencies to EPAct levels and from EPAct to CEE levels.

- Improved Rewind Practices – the savings from better processing of the repair/rewind process such as closer control of the burnout stage of processing.

- Correct Motor Sizing – the savings from selection of motors to operate in the range of 65% to 95% of rated capacity to take advantage of the operating efficiencies in this range.

- Pump Systems Efficiency Improvements – the saving from ASD control of the driving motor and/or the improved design of the system through such improvements as better pumps, more efficient piping, and eliminating unnecessary flows.

- Fan Systems Efficiency Improvements – the savings from ASD control of the motor drive and/or the improved design of the system through such improvements as better fans and blowers, ducting, and flow design.

- Compressed Air Efficiency Improvements – the savings from such improvements as better control of compressed air drives and/or the improvement in air delivery systems through surge tanks, leakage correction, and better components.

- Other Special System – other equipment savings have also been estimated

.

We have viewed the motor energy and motor systems saving opportunities in three ways:

- By sector – the tabulation of saving opportunities by industry and savings type.

- By relative degree of difficulty in achieving savings within the sector – the consideration of the barriers to achieving energy savings for the sector.

- By cross industry opportunities – the identification and measurement of five motor energy clusters.

2.4 Sector Savings.

The savings by industry and savings type show a total of motor and motor systems savings opportunities of 7,028 GWh (801 aMW) per year in the principal sectors in the four Pacific Northwest states (Table B.) The larger savings opportunities are the following:

- Approximately 45% of this savings are concentrated in two major motor energy-using sectors -- pulp and paper, and irrigation. Each of these has well over 1,000 GWh (115 aMW) potential. In both of these sectors the principal opportunities are in pump systems improvements and motor efficiency upgrades.

- The next four sectors - chemicals, mining, water and wastewater treatment, and food processing each offer opportunities for total savings of over 400 GWh (46 aMW). In these industries, pumps, air compressors, and motor upgrades are the largest opportunities.

- Among the seven motor efficiency savings areas, motor efficiency upgrades and pump systems improvements account for over 75% of the total potential savings opportunities in the PNW.

2.5 Degree of Difficulty in Obtaining Savings.

Each of the major sectors evaluated was rated as to the degree of difficulty in achieving the savings. We considered four factors in this assessment – these are:

- Concentration of the target – the difficulty in reaching the major players in the sector (i.e., the number of motor-using locations in the sector).

- Financial health of the industry – the ability and willingness to invest in energy saving projects.

- Relative receptivity to energy savings – the orientation of the industry to conservation, energy saving programs.

TABLE B

Pacific Northwest Motor Energy Savings Opportunities

	Motor Efficiency Upgrade (GWh)	Rewind Improve-ments (GWh)	Motor Downsizing (GWh)	Pump System Improvements (GWh)	Fan System Improvements (GWh)	Air Compressor Systems Improvements (GWh)	Other Systems Improvements (GWh)	Total (GWh)	Percent of Total
Sector									
Paper and Pulp and Allied Products	534	88	86	637	110	78	89	1,622	23%
Irrigation	238	56	72	1,074	-	-	7	1,444	21%
Chemicals and Allied Products	218	39	44	237	30	214	31	813	12%
Food and Kindred Products	173	22	44	95	12	37	180	563	8%
Mining	136	35	40	193	18	30	52	503	7%
Water Supply and Wastewater	63	19	19	156	10	175	3	445	6%
Lumber and Wood Products	75	32	58	42	26	56	59	348	5%
Petroleum and Coal	82	13	13	176	8	39	5	335	5%
Micro-electronics	40	6	15	30	50	20	31	192	3%
Primary Metals	76	11	14	22	11	31	16	180	3%
Aircraft and Parts	48	9	14	45	14	38	10	178	3%
Other	128	18	62	62	21	82	31	405	6%
Totals	1,811	348	481	2,768	309	800	513	7,028	
Totals (aMW)	207	40	55	316	35	91	59	802	
% of Savings	26%	5%	7%	39%	4%	11%	7%	100%	

- Relative ease of making energy saving improvement – the level of investment (including design and engineering) to convert the principal savings opportunities.

Using this scheme we divided the sectors into five categories – two manufacturing groups and three non-manufacturing areas. We rated each of the groups against the four criteria and gave an overall rating (Table C.) The ratings, 1 to 5 indicate the contribution of the factor toward achieving energy savings. A 1 rating indicates a positive contribution, and a 5, a barrier. The key findings from the degree of difficulty analysis are:

- The process industries rate high in the relative ease of achieving motor and motor systems energy savings. The large, easily identifiable facilities, are generally healthy financially, and are receptive to energy savings initiatives. Principal barriers are that they have already taken steps to make energy savings improvements and additional savings maybe more difficult and expensive to obtain. Further, many will require site-specific engineering and process change.

- Other manufacturing categories are rated lower as compared to the process industries. They are less concentrated, less healthy financially (except micro electronics) and less receptive to energy conservation. They do have many opportunities for savings, however.

- Mining is viewed by experts as having many opportunities as the handful of underground mines of the Northwest are major users of energy. There are barriers, however, as mine managers are reported to be less receptive to energy conservation, and many of the opportunities require site-specific engineering.

- Water and wastewater facilities have opportunities in pump systems, motor upgrade, and new aeration technology. The regulated utility structure presents some barrier to any significant investment and limits many changes to points in time when major construction or renovation is being planned.

- Irrigation is judged to be a very difficult sector to accomplish energy savings, although the potential savings opportunities are significant. The sector is hard to "reach" as it is made up of many, mostly small farms, and receptivity to conservation is low and somewhat affected by low power costs.

2.6 Motor Savings Opportunity Clusters

Overviewing the range of motor energy there are five major areas that standout as the primary opportunities. These have been described, assessed and measured (Table D.) These are:

TABLE C

Availability of Savings by Industry

Industry	Estimated Total Potential Savings GWh/yr		Concentration of Target	Financial Health of Industry	Relative Receptivity to Energy Efficiency	Relative Ease in Achieving Energy Savings	Summary
Process Industry							
Pulp & Paper	1,622	185	1	2	2	4	2
Chemicals	813	93	2	2	2	4	2
Petroleum	335	38	1	2	1	4	2
Primary Metal	180	21	2	2	3	3	3
General Manufacturers							
Food	563	50	3	3	2	3	3
Lumber & Wood	348	40	3	5	4	3	4
Micro electronic	192	23	1	1	3	3	2
Aircraft Parts	178	20	2	2	4	4	3
Mining	503	74	1	3	3	4	3
Water & Wastewater	445	51	2	3	3	4	3
Irrigation	1,444	165	5	3	3	2	3

Notes:
A Rating of:
1. indicates factor is positive contribution to achieving energy savings
3. indicates factor is neutral toward energy saving
5. indicates factor is an important barrier to achieving energy savings

TABLE D

Opportunity Clusters

	Principal Targets	Potential Savings in Opportunities GWh/yr		Critical Element of Program	Principal Hurdles
Motor System Improvement	All Sectors	2,600	296	• Education	• Large number of users to reach
Motor efficiency upgrade				• Distributor Assistance	• Many small transactions to influence
Rewind improvements				• Standards	
Down sizing					
Equipment Systems Improvement	Process Industries	3,000	342	• Site specific engineering assistance	Requires site specific process redesign
Pump systems				• Education	
Fan systems					
Other					
Air compressors systems	All Manufacturing	550	63	• Compressed air systems engineering	Requires expert site survey and redesign of system
				• Site surveys	
				• Distributor assistance	
				• Site surveys	
Irrigation pumping	Ground Water Irrigated Farms	1,444	165	• Education	Difficulty in reaching dispersed users
				• Distributor involvement	Low electrical rates
Refrigeration food processing	Food processors	180	21	• Refrigeration system expertise	Requires site specific redesign

- Motor efficiency upgrade through more efficient new motors, rewind process improvement, and right sizing of motors. This program has a theoretical potential of 2,600 GWh (296 aMW). To achieve savings with this program requires – education, distributor involvement in promotion, and such efforts as promoting efficient motor purchasing policies. The Alliance is addressing this opportunity cluster through several of its programs – premium motor promotion, and motor testing in particular.

- Pump and fan systems upgrade through process system or subsystem redesign for energy savings, including the use of ASDs. This area has a theoretical potential of an estimated 3,000 GWh (342 aMW) per year in the PNW. This program requires providing site-specific engineering design to integrate energy efficiency upgrade with improved process control. The Alliance is addressing this area with programs targeting ASD use in fans in refrigerated warehouses, ASD coupling venture, and two programs addressing fan speed reduction.

- Air compressor systems improvement. Poor motor energy use inplant air compressor systems is endemic across industry. In the PNW the potential saving are estimated at 550 GWh (63 aMW) per year. The programs needed to achieve these savings include better design of the systems (tube sizing, correct pressures, pressure controls), leak correction, motor selection, etc. There are a number of programs across the country, most prominently the Compressed Air Challenge, of which the Alliance is a sponsor. In addition, the Alliance has one other targeted compressed air efficiency initiative.

- Ground water irrigation pumping improvement. Energy use improvement through better pump systems purchase and maintenance and better motor selection and management. This area has a theoretical potential of 1,444 GWh/year (165 aMW). The Alliance is addressing this through several programs.

- Refrigerated food processing system improvement though system upgrade with better system controls, better refrigerant, and other changes. This requires expert onsite audit of each target system. The Alliance has an initiative in this area addressing evaporator fan controls.

2.7 Areas for Further Investigation.

In reviewing the opportunities for motor energy savings, we have identified three areas that we believe could be quite fruitful in finding ways to improve the motor energy conservation in the region. These are in three general areas – motor management, irrigation pumping, and the industry expertise resources.

1.) *Motor management programs for improving the selection and use of motors.* We recognize that the Alliance has a program underway to address this area and this recommendation is made to support this effort and to suggest several additional elements. In the past, such efforts have typically been focused on the simple upgrade of a motor to a

more efficient model. We suggest that a series of program elements be explored to develop an enriched support offering, directed at encouraging industrial motor users to improve their management of motors in their facilities. We suggest that the following elements be explored to assure that they are part of the Alliance motor management initiative:

- Plant motor audits to assure that motors are properly sized, and that high efficiency motors are used (considered) if economically justifiable. (See Appendix G for discussion of standard vs. special motors for program focus)

- Assistance in stocking motors so that the best motor is available when a motor fails in a production.

- Exploring instrumentation that can anticipate impending motor failure.

- Education in the value of right sizing and high efficiency motors.

- Establishing and promoting written purchase policies that assure the purchase of the best motor for each situation.

- Establishing standards for rewind and repair so best practices are followed in selecting rewind over new motor purchase and in purchasing rewind services.

We view such a program as an integrated program incorporating a menu of elements and oriented to all of the needs of the motor user beyond just energy conservation, including such benefits as lower stocking costs, reduced production downtime, and lower costs.

2.) *Irrigation using ground water pumping*. As the second largest motor energy use in the region, this sector should be explored for opportunities. A first step would be the collection of more specific information for the regional studies of irrigation. Of particular interest would be:

- A deeper understanding of pump systems that are used including depths of wells, hours of use and how this varies across the area and by irrigation methods.

- The pump system supply infrastructure including pump and pump system distribution systems, repair infrastructure and manufactures presence and activities.

- Statistics as to the population of pumps and motors including size, age, efficiencies and other information of this type.

- Review of the history of irrigation conservation programs in the region as to their degree of success, which elements worked and which did not.

- A projection of the higher electricity costs that irrigators are likely to be experiencing in the future.

Many observers believe that the sharply increased rates that farmers will have to pay in next five years will bring a major change in the attitude of farmers toward energy conservation.

3.) *Industry specific resources for improving motor energy using process.* Pumps, fans and other equipment used in most industrial process often have substantial opportunities for energy savings; however, achieving these savings often requires substantial process change. This in turn requires detailed and specific knowledge of the industry, the process targeted and the site specifics of the motor using application. A resource center could be established that would have the requisite technical knowledge to support motor energy conservation targeted at an industry that could be drawn upon by that industry.

The industries with the most promise are the heavy industries that are particularly prominent in the PNW. Those with the highest priority are:

- Pulp and paper – Has a large regional presence as the largest pulp producing area of the country; largest motor energy consumer.

- Mining – Major regional presence; large motor energy consumer.

- Food preservation, particularly cold storage and processing—Sizeable industry in the region, and a fairly large energy consumer.

Other industries that have high motor energy consumption but have most of their production technology center elsewhere in the country and as a result are not believed to be as promising include chemicals, petroleum refining, and primary metals. Cooperative programs drawing on other regions may be a possibility, however.

Information needed from the three promising industries include – the history of past conservation programs as to their success and failure; the receptivity of the players in these industries to accept outside assistance; specific success stories on motor energy conservation; and a better understanding of the specific processes as to which are the most promising targets for such a program.

4.) *Evaluate and promote new energy services business models.* The fact that a large number of industrial motor systems serve specialized segments, processes, and applications that can only be addressed through highly customized engineering approaches suggests that the Alliance might devote more effort to understanding and enhancing the region's infrastructure for providing these specialized technical services. While there is likely to be enough appropriate technical expertise available in the region, there may be a shortage of viable business models for delivering motor-related efficiency services to the market on a sustained basis.

Of relevance here may be a study Easton recently completed on the "ESCO Market" for the Energy Center of Wisconsin and NYSERDA that addressed how policymakers might enhance the prospects for sustained investment in energy efficiency projects by private Energy Service Companies. The study found that "traditional" performance contracting services have only addressed limited sectors of the economy generally excluding most industrial energy users. These traditional service providers have in the main generated one-time projects rather than sustained business relationships that can lead to long-term changes in energy system management and investment practices. At the same time, we recognized the emergence of new service business models that rely more on long-term relationships than one-time projects and include operations and maintenance services as well as capital project design and implementation. These new models may prove valid in some of the industry segments that are large users of motor energy in the Pacific Northwest.

3.0 State Motor Systems Energy Use by State.

Among the PNW states Washington, followed by Oregon, consumes over half of the total motor and motor systems energy in the region (Tables E, F, G, and H.) The primary uses in each state are:

- Washington consumes an estimated 17,965 GWh (2048 aMW) with over a quarter of this in the pulp and paper industry. The state also has the principal oil refineries and considerable deep well irrigation.

- Oregon with an estimated 10,887 GWh (1241 aMW) also has a quarter of its motor energy in the pulp and paper industry, followed by lumber and wood products, and irrigation

- Idaho with 7,667 GWh (874 aMW) is oriented to agricultural industries with irrigation at near 39%, food at 8% and chemicals (much of this agriculturally oriented) at 16%. Mining is also important at 20%.

- Montana consumes 3,995 GWh (455 aMW) in motor energy. Irrigation, petroleum and coal products, and water supply are important.