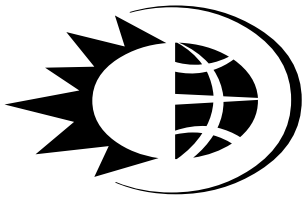

NORTHWEST ENERGY EFFICIENCY ALLIANCE

Market Assessment

Opportunities for Industrial Motor Systems in the Pacific Northwest

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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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NORTHWEST ENERGY EFFICIENCY ALLIANCE

Assessment of Industrial Motor Systems Market Opportunities in the Pacific Northwest

1. Background and Description of Conduct

1.1 Background of Project.

At the request of the Northwest Energy Efficiency Alliance (the Alliance), Easton Consultants and Xenergy have performed an assessment of the Pacific Northwest (PNW) electric motor systems market. The Alliance supports many initiatives and ventures aimed at improving the efficiency of motors and motor systems and this assessment is designed to provide a solid quantitative and qualitative overview of the entire regional motor systems market to support and direct the existing initiatives that may be developed in the future.

The Alliance is currently pursuing more than 10 programs targeted at major motor and motor systems energy saving. These have been listed in Appendix E to this report.

This assessment is viewed as a first step in gaining a detailed picture of the PNW motor and motor systems market to measure potential savings and to identify opportunities that may have been overlooked. It is realized that the report may identify promising areas that will require further research.

We have used the term "motor systems" to refer to the motor and the equipment that is directly driven by the motor such as a pump, compressor, fan, etc., along with the controls for the motor and driven equipment. The controls may sense phenomena occurring elsewhere in the operation that signals the need for a change in motor driven equipment operation.

1.2 Conduct of the Project.

The project was designed to rely heavily on the very considerable secondary research resources available on the motor and motor systems market. A wide range of sources were tapped, including energy use and industrial activity statistics from the Department of Commerce, from state administrations in the PNW, energy use studies from energy conservation interest groups, and industry associations in the eleven key motor energy using sectors. In particular we made critical use of the excellent study published by the DOE (conducted by Xenergy and Easton), "United States Industrial Electric Motor Systems Market Opportunity" and we based most of our energy savings measurements on this source. In all, over 40 secondary sources were used.

Expert interviews were used to substantially supplement the secondary research. These interviews were made with nine experts located in the PNW and active in the region's

energy conservation activities. The expert interviews included key staff at the Alliance sponsoring utilities who shared their valuable experience in energy saving programs in the industries in their service areas. We also interviewed university-based and other experts who specialize in specific industries or cross-industry, motor-use applications. These interviews were integrated into the findings and were particularly useful in understanding region-specific issues. Easton would like to thank the individuals who gave their time to support this effort.

1.3 Methodology of Measurement

1.3.1 Manufacturing.

The approach to measuring motor energy for each manufacturing industry sector in the PNW relied heavily on the Department of Commerce's, "Energy Consumption Survey", for total motor energy use, and the Department of Energy's, "Market Opportunities Assessment", for motor energy savings. Regional energy consumption and savings was scaled using the national-to-regional employment ratio applied to motor energy at the two-digit level, and at the four–digit level where that sub-sector was important in the PNW. For example, it was important to consider the four-digit pulp manufacturing sub-sector separately because of the large amount of motor energy used in pulp production in the region relative to the national consumption for pulp and paper in total.

1.3.2 Non-manufacturing.

For mining we determined the regional energy consumption and savings potential based on regional-to-national motor energy consumption at the two-digit level. For water and wastewater we scaled national energy consumption and potential savings against regional gallons of water used. For irrigation we combined and used several regional surveys of motor energy use and savings potential. Last, for microelectronics we used utility estimates of typical chip assembly plant total power consumption, motor energy use estimates as a portion of that total, and a count of plants.

1.4 Organization of the Report.

The report has been organized into five parts:

1. Background and Description of Conduct
2. Summary of Energy Savings Opportunities
3. State Motor Systems Energy Use by State
4. Structure of the PNW Motor Market
5. Profiles of Key Motor Energy Using Sectors
6. Appendices

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.

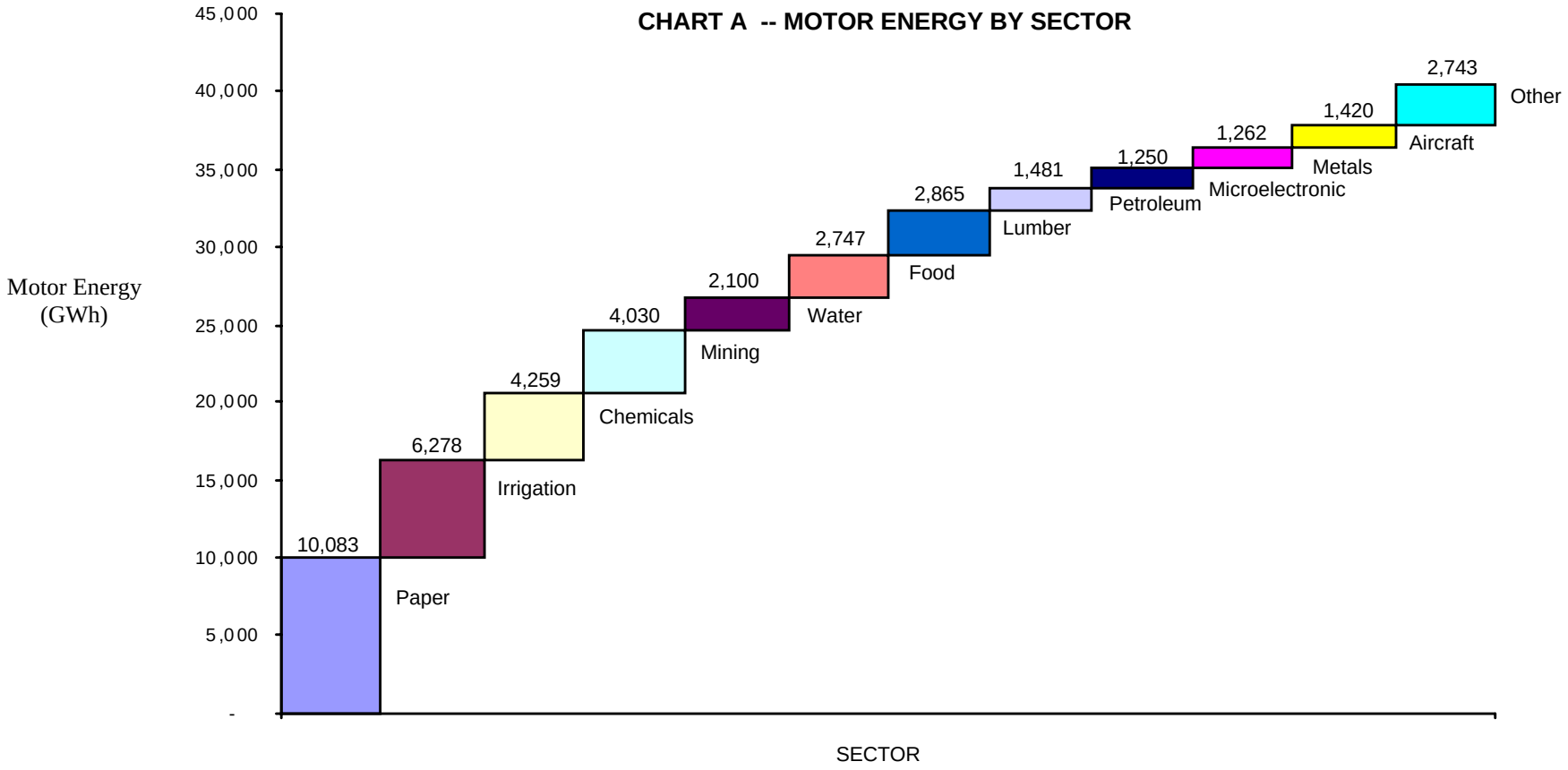


CHART A -- MOTOR ENERGY BY SECTOR
Motor Energy (GWh)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
10,083
Paper
6,278
Irrigation
4,259
Chemicals
4,030
Mining
2,100
Water
2,747
Food
2,865
Lumber
1,481
Petroleum
1,250
Microelectronic
1,262
Metals
1,420
Aircraft
2,743
Other
SECTOR

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.

TABLE E

Idaho

	Pumps		Fans		Air Compressors		Other		Total Motor Energy Use in Idaho		
Sector	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**aMW**	**% of State**
Paper and Pulp and Allied Products	23	31%	15	20%	4	5%	32	44%	73	8	3%
Irrigation	3,133	100%	0	0%	0	0%	0	0%	3,133	357	29%
Chemicals and Allied Products	342	26%	156	12%	364	28%	453	34%	1,315	150	12%
Mining	103	8%	309	24%	51	4%	823	64%	1,286	147	19%
Water Supply and Wastewater Treatment	128	46%	20	7%	110	40%	20	7%	278	32	3%
Food and Kindred Products	104	16%	48	8%	49	8%	433	68%	634	72	6%
Lumber and Wood Products	17	5%	40	12%	27	8%	249	75%	332	38	27%
Petroleum and Coal	11	60%	2	9%	3	15%	3	16%	19	2	0%
Microelectronics	53	20%	132	50%	53	20%	26	10%	264	30	0%
Primary Metals	1	8%	2	15%	2	14%	7	62%	12	1	0%
Aircraft and Parts	3	19%	4	22%	3	19%	7	41%	16	2	0%
Other	34	11%	39	13%	54	18%	178	58%	305	35	3%
Totals	3,951	23%	766	13%	719	20%	2,232	44%	7,667	874	100%

TABLE F

Montana

	Pumps		Fans		Air Compressors		Other		Total Motor Energy Use		
Sector	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**aMW**	**% of State**
Paper and Pulp and Allied Products	107	31%	67	20%	16	5%	151	44%	341	39	10%
Irrigation	430	100%	0	0%	0	0%	0	0%	430	49	13%
Chemicals and Allied Products	45	26%	20	12%	47	28%	59	34%	171	19	5%
Mining	154	8%	463	24%	77	4%	1234.6	64%	1,929	220	45%
Water Supply and Wastewater Treatment	72	46%	11	7%	62	40%	11	7%	156	18	5%
Food and Kindred Products	16	16%	8	8%	8	8%	68	68%	100	11	3%
Lumber and Wood Products	10	5%	22	12%	15	8%	135	75%	181	21	5%
Petroleum and Coal	240	60%	39	9%	62	15%	66	16%	407	46	12%
Microelectronics	13	20%	33	50%	13	20%	7	10%	66	8	0%
Primary Metals	9	9%	15	15%	15	14%	62	62%	101	12	3%
Aircraft and Parts	0	20%	0	20%	0	20%	0	40%	1	0	0%
Other	9	8%	21	19%	21	19%	61	55%	112	13	3%
Totals	1106	24%	699	17%	336	13%	1854.2	46%	3995	455	100%

TABLE G

Oregon

	Pumps		Fans		Air Compressors		Other		Total Motor Energy Use		
Sector	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**aMW**	**% of State**
Paper and Pulp and Allied Products	1,094	31%	688	20%	158	5%	1,540	44%	3,479	397	35%
Irrigation	1116	100%	0	0%	0	0%	0	0%	1,116	127	11%
Chemicals and Allied Products	154	26%	70	12%	164	28%	203	34%	591	67	6%
Mining	8	8%	24	24%	4	4%	65	64%	102	12	5%
Water Supply and Wastewater Treatment	273	46%	43	7%	236	40%	42	7%	594	68	6%
Food and Kindred Products	130	16%	60	8%	61	8%	542	68%	793	90	8%
Lumber and Wood Products	94	5%	216	12%	147	8%	1,322	75%	1,779	203	18%
Petroleum and Coal	40	60%	6	9%	10	15%	11	16%	68	8	1%
Microelectronics	131	20%	328	50%	131	20%	66	10%	655	75	2%
Primary Metals	48	9%	85	15%	80	14%	344	62%	557	63	6%
Aircraft and Parts	19	19%	23	22%	19	19%	43	41%	104	12	1%
Other	122	12%	144	14%	182	17%	602	57%	1,049	120	10%
Totals	3,229	26%	1,687	14%	1,192	14%	4,780	46%	10,887	1,241	100%

TABLE H

Washington

	Pumps		Fans		Air Compressors		Other		Total Motor Energy Use		
Sector	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**% of Sector**	**GWh**	**aMW**	**% of State**
Paper and Pulp and Allied Products	1,946	31%	1,223	20%	282	5%	2,739	44%	6,189	706	37%
Irrigation	1599	100%	0	0%	0	0%	0	0%	1,599	182	9%
Chemicals and Allied Products	568	26%	259	12%	604	28%	751	34%	2,182	249	13%
Mining	57	8%	171	24%	29	4%	456	64%	713	81	6%
Water Supply and Wastewater Treatment	493	46%	77	7%	426	40%	76	7%	1,072	122	6%
Food and Kindred Products	201	16%	92	8%	94	8%	834	68%	1,220	139	7%
Lumber and Wood Products	30	5%	70	12%	48	8%	426	75%	573	65	3%
Petroleum and Coal	582	60%	94	9%	151	15%	160	16%	986	112	6%
Microelectronics	53	20%	132	50%	53	20%	26	10%	264	30	1%
Primary Metals	52	9%	90	15%	85	14%	365	62%	592	67	4%
Aircraft and Parts	243	19%	282	22%	243	19%	532	40%	1,299	148	8%
Other	143	11%	188	15%	227	18%	719	56%	1,276	145	8%
Totals	5,967	30%	2,678	15%	2,241	16%	7,085	40%	17,965	2,048	100%

4.0 Structure of the PNW Motor Market

The structure of the PNW motor market is similar to the regional markets in other parts of the country. The differences are modest and are driven by the regional mix of industries. In the industry structure (Chart B) we have identified the five levels of players in the business – manufactures, original equipment manufacturers (OEMs), distributors, contractors, and end-users. The proportional flows are based on larger sized motors, one hp and above which includes most of the motor savings opportunities. Considering these groups:

- Manufacturers all offer broad lines of motors, but there are differences in cost and quality emphasis:
  - Baldor, GE and USEM are the largest suppliers to the region and have broad lines competitively priced with moderate emphasis on quality and high efficiency.
  - Toshiba, and Siemens offer high quality motors and somewhat shorter lines.
  - Others concentrating on selling at lower prices include Lincoln, Leeson and Magnetech.

- The manufacturers sell to distributors, 55%; to OEMs, 35%; or direct to the motor user, 10%. The portion going to OEMs in the region is less than the national percentage because there are fewer equipment manufacturers in the region. At the same time direct-to-user sales are somewhat higher because of the frequent direct sale to pulp mills, many of whom have strong direct purchase contracts with the motor manufacturer. Weyerhauser is a prominent case in point.

  OEMs purchase an estimated 35% of the motors sold in the region. These are manufacturers of machinery and equipment going to all markets and include industrial and agricultural pumps, fans and blowers, machine tools, HVAC equipment and other items. These companies tend to purchase the lowest cost motor as they usually are forced to compete on low first cost, not long-term economic return. Many OEMs have distributors in the region who sell some replacement motors. One area of research would be to identify those OEMs that sell a large share of their equipment to regional customers. Areas that might be considered are OEMs selling to the large regional motor users such as the pulp and paper, irrigation, or lumber and wood products.

- Approximately 55% of the manufacturers' sales are distributed through motor distributors who sell motors and usually other products. Distributors can be divided into three groups:

  1. Independents of two types account for about 70% of sales and usually sell rewind services, belts and pulleys, bearings, and other motor related products along with motors. These distributors usually have only one location. They vary in their marketing approach. One group accounting for 20% of the distributors emphasize sales of higher-efficiency motors and provide value-

added services such as technical advice and information. The remaining 80% are order takers who offer only price and availability.

2. Electrical supply chains such as Grainger and GE Supply provide motors as part of their broad line of electrical parts and components.

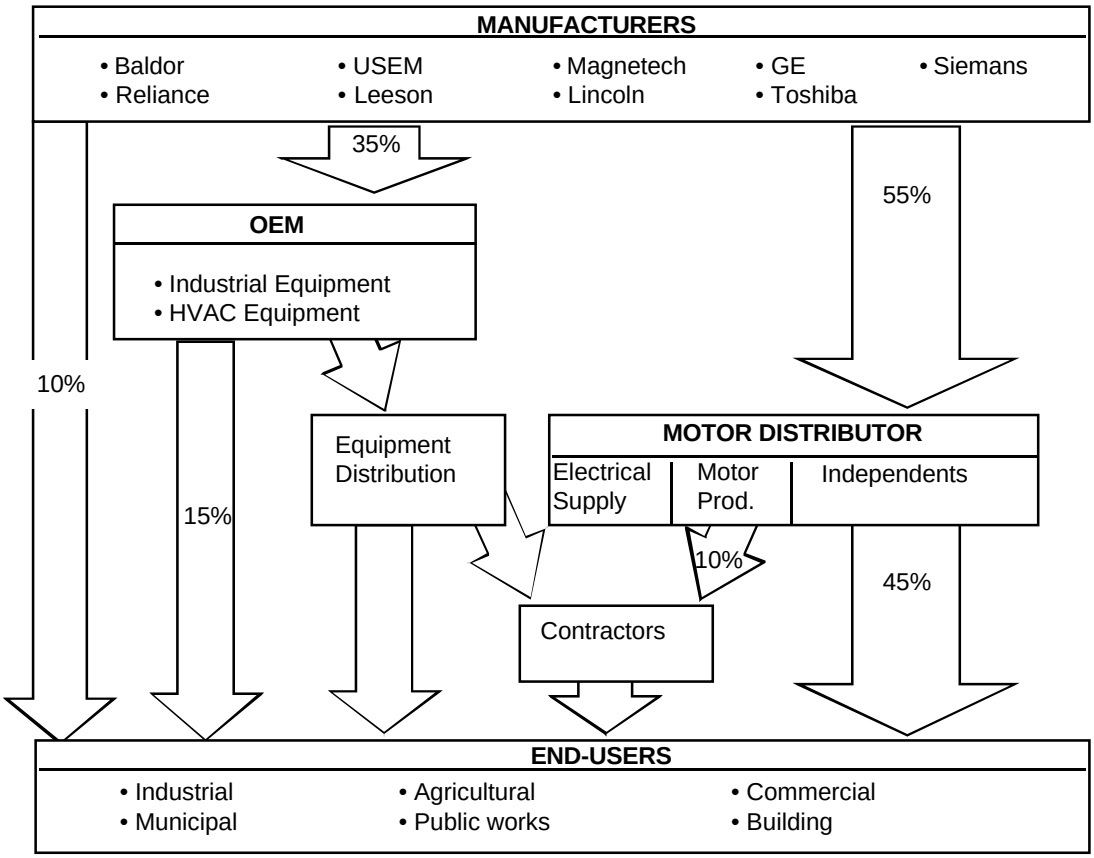
3. Motion products chains offer motors as part of a line of transmission, belts, pulleys, bearings and other drive train components. They offer technical advice and the best of them provide many value added services such as plant motor inventory and rationalization services.

Distributors sell mainly to end-users, 45% of motors, for retrofit and failed motor replacement, but 10% does go to contractors installing equipment of various types, the largest being HVAC.

End-users are primarily industrial plants, but the users also include commercial buildings, public works, and agricultural customers.

CHART B

Motor Distribution in the PNW



Note: Percent expressed as percent of all motors.

5.0 Profiles of Key Motor Energy Using Sectors

5.1 Pulp and Paper
5.2 Irrigation
5.3 Chemicals & Allied Products
5.4 Mining
5.5 Water and Wastewater
5.6 Food and Kindred Product
5.7 Lumber and Wood Product
5.8 Petroleum and Coal Product
5.9 Semiconductor Fabrication
5.10 Primary Metals

5.1 Paper and Pulp
(SIC 26)

Overview of Sector Motor Energy

		National	Pacific Northwest		
		Energy	Energy Use		% of
		Use			National
SIC	Segment	(GWh)	(GWh)	(aMW)	
26	Paper and Allied	103,992	10,083	1,151	9.7%
2611	Pulp Mill	6,707	4,967	567	74.1%
2621	Paper Mill	57,756	3,200	365	5.5%
2631	Paperboard Mill	27,711	1,613	184	5.8%
	Other segments	11,818	304	35	2.6%
		Motor Energy			
		Idaho	Montana	Oregon	Washington
SIC	Segment	(GWh)	(GWh)	(GWh)	(GWh)
26	Paper and Allied	73	341	3,479	6,189
2611	Pulp Mill	-	-	1,542	3,425
2621	Paper Mill	3	-	812	2,385
2631	Paperboard Mill	61	341	1,017	195
	Other segments	10	1	109	185
		PNW Motor Use			
		In Place	Annual		
SIC	Segment		Sales		
26	Paper and Allied	14,512	1,959		
		Motors in Place			
		Idaho	Montana	Oregon	Washington
SIC	Segment	(units)	(units)	(units)	(units)
26	Paper and Allied	96	513	4,988	8,915
		Motor Energy by Application			
SIC	Segment	Fans	Pumps	Compressor	Other
26	Paper and Allied	20%	31%	5%	44%

Description of Market

Major Industry Trends:

- The pulp and paper industry has grown at a rate of 4% per year in dollar terms, but is highly cyclical.

- The Pacific Northwest represents 5% of the national value of shipments.

- Per capita demand for paper and allied products is growing at a declining rate. The per capita consumption increased by 1.8% annually from 1960 to 1980, 1.6% annually from 1980 to 1990, and is expected to grow at 0.6% annually from 1990 to 2040.

- Paper and allied products is the most capital intensive of manufacturing industries with new capital expenditures averaging 10.4% of revenues annually.

- Paper and allied products rank second as the most energy intensive industry in the manufacturing sector.

- Paper and allied products on average spends only 1% of revenue on R&D, much less than the average for all manufacturing industries.

Relation of Regional Market to National Market:

- PNW region is a significant portion of U.S. national pulp manufacturing capacity (approximately 61%) but only 10% of the national total for all pulp and paper products.

- Wood and wood pulp combined are 36% of total non-labor costs in the industry and this resource has established the PNW as a primary basic paper and board producing area.

- 70% of timber has historically come from federal lands – this has radically declined recently.
    - Federal timber sales have fallen from 26 million cubic feet to 4 million cubic feet in the last 10 years due to restrictions and increased imports.
    - Smaller firms that relied upon timber from federal lands are especially hurt.

Principal Types of Facilities:

1) Integrated pulp and paper mills – very large companies
2) Smaller, unintegrated separate specialized mills
3) Other paper finishing mills – cutting, texturizing, coloring, etc.

Profiles of Key Manufacturing Locations:

			Number of	
			Production	
Company	**City**	**State**	**Employees**	**Facilities**
Boise Cascade Corp.	Boise	Idaho	900	HQ + Plant
Stone Container Corp.	Missoula	Montana	700	HQ + Plant
Fort James Corp	Clatskanie	Oregon	1,100	Plant
Georgia Pacific	Toledo	Oregon		
International Paper	Gardiner	Oregon		
James River Corp.	Clatskanie	Oregon		
Pope and Talbot Inc	Portland	Oregon	100	HQ + Plant
Weyerhaeuser Paper Co	Springfield	Oregon		
Willamette Industries Inc	Portland	Oregon	400	HQ + Plant
Boise Cascade Corp.	Vancouver	Washington		
Boise Cascade Corp.	Steilacoom	Washington		
Daishowa America	Pt. Angeles	Washington		
Fort James Corp	Camas	Washington	1,650	Plant
Grays Harbor Paper	Hoquiam	Washington		
Inland Empire Paper	Spokane	Washington		
Kimberly Clark Corp	Everett	Washington	1000	Plant
Longview Fibre	Longview	Washington		
Northern Pacific	Longview	Washington		
Ponderay Newsprint Co.	Usk	Washington		
Port Townsend Paper	Port Townsend	Washington		
Potlatch	Spokane	Washington		
Rayonier	Pt. Angeles	Washington		
Scott Paper Co.	Everett	Washington		
Simpson Investment Co	Seattle	Washington	900	HQ + Plant
Simpson Tacoma Kraft	Tacoma	Washington		
Weyerhaeuser Co	Auburn	Washington	1,000	HQ + Plant
Weyerhaeuser Co	Longview	Washington	1875	Plant
Weyerhaeuser Forestlands	Auburn	Washington	1000	Plant
Weyerhaeuser Paper Co	Everett	Washington		
Weyerhaeuser Paper Co	Cosmopolis	Washington		
Weyerhaeuser Paper Co	Longview	Washington		

Energy Efficiency

Total Motor Energy Use:

- Paper and allied products rank second as the most energy intensive industry in the manufacturing sector, and pulp, paper, and paperboard mills account for about 12% of total manufacturing energy use in the U.S.

- Purchased energy, of which motor energy is the most significant component, is 17% of total non-labor costs for the paper and pulp industry.
    - However, since 56% of electricity is self generated, total energy use is actually more than double the purchased energy.

- Total electric energy purchased dropped by about 3% annually from 1972-1986 but since then has leveled off, partly as a result of the increased use of self-generated power which rose from 40% to 56% from 1972 to 1993.

- The industry uses many large motors.

Opportunities for Energy Efficiency Improvements:

A number of studies have been done of the opportunity for motor energy savings in the Pulp and Paper industry. Some have shown that there is a potential of on the order of 30%, but a lower level of 15% appears more achievable:

- Scandinavian paper and pulp mills are significantly less energy-intensive than U.S. mills, indicating that there is a potential for U.S. mills to improve efficiency with a substantial savings potential. This study has shown that such improvements as replacing worn pumps, downsizing oversized equipment, installing variable speed drives etc., for pumps greater than 70 hp could cost-effectively reduce electricity use in pulp and paper mills by up to 30%. While this savings potential is based on a study conducted on Scandinavian paper and pulp mills, experts consider comparable savings potential to be available in the U.S. as well.

- Oregon Department of Energy and the Bonneville Power Administration both concluded after surveying plants that realistic savings potential is about 10%.

- Portland General Electric estimated the “economically practical” savings potential to be 16%.

- Puget Power’s “achievable” savings estimate was 20%, with a technical savings potential of 23%.

Expert observers have identified the following areas:

- Pump systems are seen to be the largest opportunity. Specific savings are found in substitution of ASDs for throttling, by-pass valves and other energy dissipating designs among the many pump applications in the industry.
    - Documented savings project --- ASD on a boiler feedwater pump – 26% savings.
    - Documented savings project --- ASD on whitewater pump and downsize motor – 69% savings.

- Larger companies in this industry have corporate involvement in the purchasing policy for motors and energy for their mills. Some have been very proactive in motor management programs and cooperative programs with the manufacturers for motor improvement such as the IEEE 841 hazardous duty motor. Their improvements have not yet been adopted by most companies, and motor upgrade presents opportunities.

- ASD's on other drives, beyond pumps, have some opportunity such as:
    - Fans used for pneumatic conveying and air movement.
    - Debarker feeders.
    - Boiler forced draft fan (A demonstration project had savings of 70%).

- Industry experts stated that there are motor energy efficiency opportunities with compressed air.

Savings Potential:

- Motor systems upgrades.
    - An opportunity for savings exists in the motor upgrade category because of the large number of large horsepower motors.

- Rewind improvements.
    - There is modest opportunity for improvement in rewinds. The large population of large motors inclines the industry toward a substantial number of rewinds.
    - Large motors represent 59% of motors vs. 45% in all manufacturing.

- Motor downsizing.
    - There is a modest opportunity for motor downsizing.

- Pump systems improvement.

- Major savings opportunities in pump system redesign.

- Fan systems improvements.
  - Modest opportunity in fan systems.

- Air compressor improvements.
  - There is only modest opportunity for motor systems energy savings in air compressors.

Summary of Savings Potential

	National	PNW	
Type of Savings	**GWh/year**	**GWh/year**	**Percent**
Motor Efficiency Upgrade	5,275	534	33%
Rewind Improvements	870	88	5%
Motor Downsizing	845	86	5%
Pump System Improvements	6,293	637	39%
Fan System Improvements	1,082	110	7%
Air Compressor Systems Improvements	773	78	5%
Other Systems Improvements	881	89	5%
Total:	16,019	1,622	100%
Total Motor Energy	99594	10083	
Percent Savings Potential	16%	16%	
Percent of National Industry Savings			10%

Possible Barriers to Energy Efficiency:

The industry is relatively receptive to energy savings proposals; at the same time it has substantial internal capabilities. However…

- Many of the pulp and paper mills in the PNW that depend on wood from federal lands are on the "ragged edge;" they are unsure whether they will still be in business next year so are unlikely to be worrying about long-term efficiency gains.
  - Selling more expensive premium motors to these companies is very difficult.

- Many of the potential efficiency opportunities (like with ASD's on pump drives) require extensive engineering studies of the specific system in which the pump is used so the pump can be properly integrated into process system.

Impact of New Technologies:

- Kraft Pulping – Accounts for about 80% of all pulp produced in the United States. Increasing the efficiency of this new process holds a high savings potential as it affects a high percentage of the energy consuming part of the industry.

- Control Technology – Sensors, computers, control systems, etc., are developing rapidly and can lead to the more efficient use of the motors themselves and offer the potential for a large decrease in energy use.

- Pinching – Process integrating heat and motor systems together within a mill. Allows for significant energy savings.

Conclusions:

Because of the huge amount of motor energy used there are major opportunities for savings throughout the industry, particularly in the largest pulp mills.

Pump energy reduction through process redesign and use of ASD's is the largest opportunity. Obtaining these savings often requires process redesign with substantial engineering inputs and site specific design.

Motor management programs and rewind process improvement also have potential because of the large number of large motors installed.

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Personal Communications – Gary Mitchell and Doug Findley, Portland General Electric.

5.2 Irrigation
(SIC 4971)

Overview of Sector Motor Energy

Pacific Northwest Irrigation by State					
State	**Total Irrigated Land**	**Well Irrigation**		**Surface Irrigation**	
	1,000 Acres	**1,000 Acres**	**%**	**1,000 Acres**	**%**
Idaho	3,490	1,307	37.4%	2,183	62.6%
Montana	1,990	137	6.9%	1,853	93.1%
Oregon	1,950	501	25.7%	1,449	74.3%
Washington	1,430	502	35.1%	928	64.9%
Total	8,860	2,447	27.6%	6,413	72.4%

Irrigation Energy					
	Number of Farms	**Number of Pumps**	**Pump Energy**		
State			**GWh**	**aMW**	**%**
Idaho	7,726	19,383	3,133	358	49.9%
Montana	3,423	7,121	430	49	6.8%
Oregon	7,065	17,703	1,116	127	17.8%
Washington	5,876	14,258	1,599	183	25.5%
Total	24,090	58,465	6,278	717	100.0%

Irrigation Energy					
	Number of Farms	**Number of Pumps**	**Pump Energy**		
State			**GWh**	**aMW**	**%**
Idaho	7,726	19,383	3,133	358	49.9%
Montana	3,423	7,121	430	49	6.8%
Oregon	7,065	17,703	1,116	127	17.8%
Washington	5,876	14,258	1,599	183	25.5%
Total	24,090	58,465	6,278	717	100.0%

Control of Land						
	Number of Farms			**Acres of Irrigated Land**		
	Total	**Over 500 Acres**		**Total**	**Over 500 Acres**	
State		**Number**	**%**		**Number**	**%**
Idaho	13,376	1,625	12%	3,183,733	1,902,707	60%
Montana	7,656	1,155	15%	1,936,292	1,113,362	57%
Oregon	9,512	715	8%	1,587,152	911,099	57%
Washington	9,741	690	7%	1,434,800	784,186	55%
Total	40,285	4,185	10%	8,141,977	4,711,354	58%

Description of PNW Irrigation Market

- The PNW is a major user of irrigation and has about 25% of all irrigated land in the U.S.

- Irrigation can be divided by source of water – either ground or surface.
  - Ground water sources are accessed by pump, usually deep well. Water is usually distributed to the field by sprinkler, but some are canal delivered.
  - Surface water is moved to the field by canal or aqueduct and usually by gravity.

- Most of the pump energy is used to raise the ground water to the surface, however, some pumps are found in surface distribution systems. Over 80% of pump energy is used in ground water lifting, but this can vary locally.

- 98% of all agricultural water pumps in the Pacific Northwest are driven by electric motors.

- The irrigated acreage in the PNW has been quite stable over the past 10 years, but the ground source portion has expanded by 4% during this period.

- Use of pumps is seasonal, averaging 1500-2200 hours per year, concentrated in summer and early fall.

- About half of the ground water-irrigated farms use pumps over 40 hp.

Profile of the Four States:

- Idaho
  - Has the most irrigated land at 3.2 million acres, 1.3 million acres are irrigated by ground water.
  - Ground water users are concentrated in the state's arid southern region.
  - About 60% of Idaho's well-using farms cite it as their sole irrigation source.
  - $90 million a year is spent on electricity.

- Montana
  - Most of the state's irrigated land is along the southern Idaho/Montana border.
  - Only 7.1% of irrigation water stems from ground water due to the abundance of lakes and streams.
  - $11.2 million of pumping energy is consumed in lifting ground and transporting surface water.

- Oregon
  - Most irrigation is concentrated in the north-central and southeast regions of the state along the Oregon-Idaho border.
  - About $30 million a year is spent on electricity to drive these pumps.

- Washington
  - Irrigation is concentrated in central Washington, with Grant County alone containing a third of the irrigated acres.
  - During summer growing season, irrigation needs rise dramatically, especially in central Washington where rainfall is infrequent and the majority of irrigated land resides.
  - $45 million a year is spent on electricity to drive these pumps.

Conservation Programs:

- The region has had a number of conservation programs including:
  1) Bonneville Power Administration Waterwise Program
  2) Idaho Power Company Agricultural Choices Program
  3) Montana Power Company Irrigation Pilot Program

- The savings from these programs has been significant with nearly 1% a year improvement reported in some years.

Experts See Opportunities for Energy Efficiency Improvements in Several Areas:

- Motors selection and management. Farmers are reported to have poor practices in the selection and management of motors, including:
  - Oversizing of the pump to the task.
  - Poor rewinding practices.
  - Little use of high efficiency motors, although this is limited by the large number of special motor types used that do not have premium versions such as vertical shaft drives.

- Pump systems improvement. Many irrigation pumps are reported to operate at unacceptably low efficiencies and consume much more energy than is necessary. The four primary causes of these low efficiencies are:
  - Mismatches of pump, irrigation systems, and changed depth to water source.

- Improperly designed or sized fittings or use of throttling valves to control flow/pressure.
- Pump wear due to abrasion or cavitations.
- Poor maintenance practices.

- Two other potential areas for irrigation energy savings (beyond motor and motor systems) can come from:
  - Improved irrigation scheduling to better manage timing and amount of water applied to avoid over watering.
  - Informing farmers of latest information on irrigation practices and equipment and educating them about the hardiness of the efficient motors to break down their resistance to use of high efficiency motors.

Savings Potential:

- Motor systems upgrades.
  - Important potential here as farmers resist efficient motor use.

- Rewind improvements.
  - Some opportunity.

- Motor downsizing.
  - Experts see an opportunity here.

- Pump systems improvement.
  - The major opportunity as many pumps poorly selected and maintained.

Summary of Savings Potential:

	PNW	
Type of Savings	**GWh/year**	**Percent**
Motor Efficiency Upgrade	238	16.5%
Rewind Improvements	56	3.9%
Motor Downsizing	72	5.0%
Pump System Improvements	1070	74.1%
Other System Improvements	7	0.5%
Total:	1,444	100%
Total Motor Energy	6,278	
Percent Savings Potential	1,444	23%

Possible Barriers to Energy Efficiency:

- Many small farmers are wary of energy efficient motors and feel they are not cost effective and that they are less durable and hardy.

- While pump management programs are an opportunity, many such programs have been in place for many years with little success because of the resistance of the farmer to this type of operational discipline.

- The low hours of usage of pumps, typically 1500-2200 hours per year, make replacing motors and improving motor systems more difficult to justify economically.

- The industry is very fragmented -- many small companies/farmers.

- Special low irrigation electric price rates reduce the effort to conserve energy.
    - In central Washington, for example, agricultural power costs only 2 cents a kilowatt-hour.

Conclusions:

There is substantial opportunity to save motor and motor systems energy in irrigation as systems are often oversized, efficient motors are uncommon, and pump systems are often poorly designed and maintained. However, barriers are substantial as there are several thousand farm operators who must be educated and convinced. Further, most power is sold at very low rates limiting the economic incentive. On the other hand, there are strong indications that electric rates will rise dramatically

Sources Used:

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"Farm and Irrigation Survey (1994)," Department of Agriculture.

5.3 Chemicals and Allied Products (SIC 28)

Overview of Sector Motor Energy

Chemicals and Allied Products		National	Pacific Northwest		
		Energy Use	Energy Use		% of National
SIC	Segment	(GWh)	(GWh)	(aMW)	
28	Chemicals and Allied Products	143,056	4,529	517	3%
2813	Industrial Gases	22,142	1,082	124	5%
2819	Industrial Inorganic	37,947	1,921	219	5%
2821	Plastics and Resins	14,435	279	32	2%
2865	Cyclic Crudes	5,351	59	7	1%
2869	Industrial Organic	29,986	128	15	0%
2873	Nitrogenous Fertilizers	3,884	204	23	5%
2874	Phosphatic Fertilizers	3,518	412	47	12%
	Other	25,793	444	51	2%
		PNW Motor Use (Units)			
SIC	Segment	Motors in Place	Annual Sales		
28	Chemicals and Allied Products	19,812	2,752		

		Motor Energy Use (GWh)			
SIC	Industry	Idaho	Montana	Oregon	Washington
28	Chemicals and Allied Products	1,315	171	591	2,182
		Motors in Place (units)			
SIC	Segment	Idaho	Montana	Oregon	Washington
28	Chemicals and Allied Products	4,609	927	3,998	10,278
		New Motors Sold (units)			
	Segment	Idaho	Montana	Oregon	Washington
28	Chemicals and Allied Products	668	134	580	1,490
		Motor Energy by Application			
	Segment	Fans	Pumps	Air Compressors	Other
28	Chemicals and Allied Products	12%	26%	28%	34%

Description of Market

Major Industry Trends:

- The chemicals industry has grown at a compounded average growth rate of 6% over the past 7 years.
- The U.S. Chemicals industry is the world leader of this complex and diverse industry.
- The Chemical industry is highly capital intensive, particularly in the basic chemicals area with heavy motor energy use. Downstream fabricators such as plastics molders are much less so.
- The industry is technology and R&D intensive, particularly the basic chemicals area. Research by firms is highly proprietary, and seldom shared.
- The U.S. Chemicals industry has been required to devote a significant portion of capital spending on pollution abatement, primarily related to Clear Air Act compliance, and as an industry has been quite compliant.

Relation of Regional Market to National Market:

- The Pacific Northwest represents about 3% of the national value of chemicals shipments.
- PNW region tends to have fewer of the basic chemicals producers and is mainly specialty chemical "batch" processing. As a result, it is less energy intensive than the chemical industry near source materials such as southwestern petrochemical plants.
- The PNW does have an important part of its output supplying other industries in the region, particularly for:
  - Pulp and paper -- bleach, caustic, etc.
  - Agriculture -- fertilizer and insecticides.
- Changes in the customer market can change the regional market for the chemical supplied. A case in point is the shift of the pulp and paper industry away from chlorine bleaching.

Profiles of Key Manufacturing Locations:

			Number of	
			Production	
Company	**City**	**State**	**Employees**	**Facilities**
Agrium CPO	Conda	Idaho	287	Plant
FMC Corp	Pocatello	Idaho	500	Plant
J R Simplot	Pocatello	Idaho	500	Plant
Melaleuca	Idaho Falls	Idaho	1,700	HQ + Plant
Solutia Inc	Soda Springs	Idaho	400	Plant
Cell-tech	Klamath Falls	Oregon	500	HQ + Plant
Chemical Co	Portland	Oregon	455	Headquarters
Chevron Inc.	St. Helens	Oregon		
Elf Atochem	Portland	Oregon		
Rodda Paint Co	Portland	Oregon	420	Headquarters
Titanium	Albany	Oregon	340	Plant
Bayer Corp	Spokane	Washington	340	Plant
Chevron Chemical	Kennewick	Washington		
Elf Atochem	Tacoma	Washington		
Kalama Chemical	Kalama	Washington		
Kemanord Inc.	Moses Lake	Washington		
Mc Gregor Corp	Colfax	Washington	300	Headquarters
Morton Thiakol	Elma	Washington		
Occidential Chemical	Tacoma	Washington		
Patho-Genesis Corp	Seattle	Washington	273	Headquarters
Penford Corp	Bellevue	Washington	398	Headquarters
Union Charbide	Tacoma	Washington		

Energy Efficiency

Total Motor Energy Use:

- The chemical industry nationally ranks among the top of all manufacturing industries in terms of the economic impact of energy costs.
    - First in total energy costs.
    - First in net electricity demand.
    - First in motor system electric use.
    - Fifth in motor system costs as a percentage of operating costs.

- Several of the largest and most sophisticated chemical companies have been leaders in the design of their plants for high motor efficiency. In particular, Dow Chemical and DuPont have advanced corporate policies for motor design and have led in such developments as the IEEE 841, harsh conditions, motor development.

- Washington State alone consumes over 55% of all chemical industry energy use in the PNW.

- Industrial Gases (2813) and Industrial Inorganic (2819) consume two thirds of motor energy use in the chemical industry in the PNW. The industrial gas industry is one of the highest consumers of motor energy, and their specialized plants have been highly engineered for efficiency.

- The saturation of EPAct compliant or more efficient motors is very high in the chemical industry, but the use of motors with ASDs is relatively low.

- Motor energy use is high in large compressed air systems.

- 14 % of motors in place (on a national basis) meet EPAct standards, a high percentage considering that the EPAct motor was a premium motor only two years ago.

- 13% of motors in place (on a national basis) are equipped with ASDs, but ASDs control only 2% of energy.

- Average part load is 65% (manufacturing average is 62%).

- There are many large motors. 59% of energy is used by motors with greater than 200 hp (on a national basis).

Opportunities for Energy Efficiency Improvements:

- The greatest potential for energy savings in the chemical industry is in ASD control of pumps and compressors which move product – liquids and gases through the production process.

- The chemical industry ranks extremely high for the potential dollar savings that can be realized by improving motor efficiency for these processes.

- Significant amounts of energy use in the chemicals industry can be saved through the use of high efficiency motors, as many motors are large horsepower.

Savings Potential:

- Motor systems upgrades
    - Opportunities because of the numbers of larger motors. (While the percent efficiency gain in large motors by a move to premiums is low, the typically long hours of use offers good kWh savings)

- While the industry uses many special enclosure motors such as severe and hazardous duty types, these typically have premium versions available.

- Pump systems improvement
    - Many opportunities through process changes and use of ASDs.

- Air compressor improvements
    - Opportunity through motor controls and system redesign.

Summary of Savings Potential:

Type of Savings	GWh/year	GWh/year	Percent
Motor Efficiency Upgrade	6,939	218	27%
Rewind Improvements	1,255	39	5%
Motor Downsizing	1,409	44	5%
Pump System Improvements	7,556	237	29%
Fan System Improvements	942	30	4%
Air Compressor Systems Improvements	6,813	214	26%
Other Systems Improvements	994	31	4%
Total:	25,908	813	100%
Total Motor Energy	144,362	4,259	
Percent Savings Potential	19%	19%	
Percent of National Industry Savings			3%

Possible Barriers to Energy Efficiency:

- While the industry has many opportunities for motor energy savings, many of these will require some degree of process redesign to obtain.

- The industry nationally, and particularly in the PNW, is very diverse and this presents a large variety of unique motor use situations.

<u>Conclusions</u>:

While the chemical industry nationally has substantial opportunities for motor energy savings, the chemical industry in the PNW is comparatively small and tends to be batch processing. It does have modest opportunities in motor upgrades, ASD pump motor drives, and air compressor systems redesign.

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U.S. Department of Commerce, Bureau of the Census "Statistical Abstract of the United States 1998: The National Data Book."

DOE Office of Industrial Technologies (Xenergy the contractor), "United States Industrial Electric Motor Systems Market Opportunities Assessment."

EPRI, "Potential for the Increased Efficiency in Motors in the Chemical and Processing Industries," EPRI TR-106655, August 1996.

Reference USA – http://reference.infousa.com/

5.4 Mining
(SIC 10 and 14)

Overview of Motor Sector Energy

Mining		National	Pacific Northwest		
		Energy Use	Energy Use		% of National
SIC	Segment	(GWh)	(GWh)	aMW	
10	Metal Mining	46,000	3,663	418	8%
14	Nonmetallic Mining	8,433	367	42	4%
	Total mining	54,433	4,030	460	7%
		PNW Motor Use (Units)			
SIC	Segment	Motors in Place	Annual Sales		
10 and 14	Mining	30,562	3,660		

		Motor Energy Use (GWh)			
SIC	Segment	Idaho	Montana	Oregon	Washington
10 and 14	Mining	40%	30%	10%	20%

		Motors in Place (units)			
SIC	Segment	Idaho	Montana	Oregon	Washington
10 and 14	Mining	12,224	9,169	3,057	6,112
		Motor Energy by Application			
SIC	Segment	Fans	Pumps	Compressors	Other
10 and 14	Mining	8%	24%	4%	64%

Description of Market

Major Industry Trends:

- Each of the minerals mined in the PNW has its own international market which are driven by global market trends and pressures. All these markets are subject to considerable volatility.

- Silver has experienced a strong increase in production in the past three years due to a strong increase in price (it has recently begun to weaken).

- Gold has held a relatively stable high price over the past five years and this has supported production. The price has recently begun to weaken.

- Copper is selling at below its recent historical prices which has caused a decline in production of nearly 30% in 1998-1999.
    - Copper production is concentrated in 15 mines that account for 96% of domestic production.

Relation of PNW to the National Market:

- Northern Idaho and Eastern Washington is a major gold and silver producing area with most mines producing both ores, but quite a few mines producing silver as the primary product.
    - These two states produce 6% of the national output of gold and Idaho, near half of the silver.

- Montana is a major producer of copper.
    - The state produces 5 to 10% of the national output of copper principally in 3 mines.

Profiles of Key Manufacturing Locations:

Company	City	State	Number of Production Employees	Facility
Coeur D'Alene Mines Corp	Coeur D'Alene	Idaho	831	HQ + Plant
Hecla Mining Co.	Coeur D'Alene	Idaho	1,184	HQ + Plant
Sunshine Mining & Refining Co.	Boise	Idaho	335	HQ + Plant
Sunshine Mining & Refining Co.	Kellogg	Idaho	253	Plant
Asarco Troy Mine		Montana		
Decker Coal	Decker	Montana	300	HQ + Plant
Stillwater Mining Co.	Nye	Montana	800	Plant
Centralia Mine	Centralia	Oregon		
Asamera Mineral	Wenatchee	Washington		
Cominco American Inc.	Spokane	Washington	775	HQ + Plant
Pegasus Gold Inc.	Spokane	Washington	606	HQ + Plant
Royal Oak Mines Co.	Kirkland	Washington	1,039	HQ + Plant

Energy Efficiency

Total Motor Energy Use:

- The major uses of motor energy use in underground mines of the type common in the PNW are:
    - Pumping of seepage water and in some situations water used for cooling.
    - Fans and blowers used for ventilation of the below ground marking areas and evaporative cooling.
    - Refrigerator compressors for work area cooling.
    - Air compressors for tool drivers and some ambient air cooling.
    - Hoists for moving personnel, equipment and ore to the surface.
    - Process drives in ore processing equipment.

- The mines have a high utilization of equipment, running close to 8,700 hours per year.

Opportunities for Energy Efficiency Improvements:

- Pumps for lifting water from working levels require high head pressures. These can be fitted with ASD and pumps and pump systems can be improved for major motor energy savings.

- Improvements of the air compressor system through ASD control and system piping improvement.

- The use of compressed air for the cooling of mines is extremely inefficient; there are many ways to improve this area of energy use through water spray, evaporative cooling, etc.

- Fans used for ventilation in deep shaft mines can be made more efficient with ventilation ducting redesign and be fitted with ASDs to improve efficiency.

Savings Potential:

- Motor systems upgrades.
    - Some potential.
- Pump systems improvement.
    - The major potential – largest user of motor energy.
- Fan systems improvement.

    - Improvement of ventilation system design.
- Air compressor improvements.
    - Some potential.
- Other system improvements.
    - Some potential in ore processing drives.

Summary of Savings:

	PNW	
Type of Savings	**GWh/year**	**Percent**
Motor Efficiency Upgrade	136	27%
Rewind Improvements	35	7%
Motor Downsizing	40	8%
Pump System Improvements	193	38%
Fan System Improvements	18	3%
Air Compressor Systems Improvements	30	6%
Other Systems Improvements	52	10%
Total:	503	100%
Total Motor Energy	4,030	
Savings as a Percent of Total Energy		12%

Barriers to Motor Energy Efficiency:

- Utility energy services professionals report that many mine operations are not energy conscious and are resistant to efficiency programs. Due to the volatility of the markets they serve, many mines require short payback periods for any capital investments. This is suggested by anecdotal evidence indicating that many mining operations purchase "used" equipment. Further, many of the efficiency opportunities require site specifics engineering.

- Mining locations are difficult for motor operation because of the dust and heat, particularly below ground applications. This makes it difficult to justify upgraded motor systems equipment that requires longer life to justify.

Conclusions:

The mining industry is a substantial user of motor energy, especially the major metal mines. However, the industry is reported not to be energy conscious. Many of the energy improvements require site-specific process design.

Sources Used:

DOE Office of Industrial Technologies (Xenergy the contractor), "United States Industrial Electric Motor Systems Market Opportunities Assessment."

Department of Commerce "Survey of Mineral Industries."

Reference USA – http://reference.infousa.com/

Personal Communication – John Johnson, Xenergy.

Personal Communication – Rob Gay, Avista.

5.5 Water Supply and Wastewater Treatment (SIC 4941 and 4952)

Overview of Sector Motor Energy

		Pacific Northwest	
		Energy Use	
SIC	**Segment**	**(GWh)**	**(aMW)**
4941	Water Supply and	2,100	240
	Wastewater Treatment		
SIC	**Segment**	**Motors in Place**	**Annual Sales**
4941	Water Supply and	6,888	1,023
	Wastewater Treatment		

		Motor Energy Use (GWh)			
SIC	**Segment**	**Idaho**	**Montana**	**Oregon**	**Washington**
4941	Water Supply and	278	156	594	1,072
	Wastewater Treatment				

		Motors in Place (units)			
SIC	**Segment**	**Idaho**	**Montana**	**Oregon**	**Washington**
4941	Water Supply and	912	512	1,948	3,516
	Wastewater Treatment				
		Motor Energy by Application			
SIC	**Segment**	**Fans**	**Pumps**	**Aeration**	**Other**
4941	Water Supply and	7%	46%	40%	7%
	Wastewater Treatment				

Description of Market

Major Industry Trends:

Water Supply

Water can be supplied from ground or surface sources. Surface water uses less motor energy as it usually flows by gravity.

- Pump drive motors account for the largest amount of energy used in water supply and treatment facilities.

- Equipment for aeration in wastewater treatment is also a high motor energy consuming process.

- Energy consumption by water and wastewater facilities is on the rise, and increased demand and phasing in of new drinking water purity regulations are expected to require more process steps and increased energy use by water utilities in the future.

    - Demand expected to increase by about 25% in the next 20 years on a national basis.

Relation of Regional Market to National Market:

Virtually every municipality operates a water and wastewater facility. The size will vary roughly in proportion to population, but the motor energy use will depend on volume of water moved and the topography (opportunity for gravity movement).

Water Supply

The PNW has ample rainfall in the population centers and the water supply is largely gravity movement

Wastewater Treatment

The market trends of the PNW seem to be in line with national trends. However, while many wastewater treatment plants elsewhere in the country reuse the bio-gas produced on site for heating and engine fuel, some plants in the PNW are selling that gas and using electric energy to replace it. Because of the low cost of electricity, it is more cost effective to sell the gas, and use the cheaper electricity. This results in higher electrical energy motor use in the PNW than elsewhere.

Opportunities for Motor Energy Efficiency Improvements:

A very relevant Idaho study was done in the mid 1990's; it was found that:

- 40% of pumps are over 100 hp, 6% of pumps are over 300 hp – the high percentage of large hp motors allows for higher potential energy savings if pumps are switched to energy efficient ones.

- 33% of all water pump motors have never been serviced, over 66% have not been serviced in the past five years – this suggests the potential for high-energy savings if these motors are worn out and not repaired.

- 50% of all pump motors operate year-round, with more than 60% operating more than 1,500 hours a year.

- Some pump motors upgrades show paybacks in two years with almost all demonstrating a payback of less than 10 years.

Opportunities for motor energy reduction have been identified by experts:

- Wastewater plants are increasingly using bio-gas captured from the process to feed engine drives on generators and pumps. This reduces motor use.

- Programmable logic controllers and variable frequency drives have potential in variable delivery pumps.

- Many large hp pump drives are over 30 years old with clear potential for savings through upgrade.

- ASDs on aeration equipment would help efficiency, but these are site-specific applications.

- Change from spray systems to bubble, and then to small bubble aeration systems have potential for reducing the cost of oxidation of waste flows.

Savings Potential:

- Motor systems upgrades.
    - Major opportunities because of many old large motors used.

- Rewind improvements.
    - Some opportunity.

- Pump systems improvement.
    - Opportunities in ASD in some situations, and replacement of old pump equipment.

- Aeration systems improvement.
    - New technology for aeration of wastewater.
    - Enhanced biological treatment for reduced aeration requirements.

Summary of Savings Potential:

	PNW	
Type of Savings	**GWh/year**	**Percent**
Motor Efficiency Upgrade	63	14%
Rewind Improvements	19	4%
Motor Downsizing	19	4%
Pump System Improvements	156	35%
Fan System Improvements	10	2%
Air Compressor Systems Improvements	175	39%
Other Systems Improvements	3	1%
Total:	445	100%
Total Motor Energy	2100	
Percent Savings Potential		21%

Possible Barriers to Energy Efficiency:

- Since many water supply and wastewater treatment organizations are regulated utilities, there is less incentive to invest in energy saving equipment and systems. Motor energy efficiency improvements will generally require major system redesign and investment and changes are limited to times of major facility upgrade, or new construction.

- DOE studies have found that water and wastewater managers' primary concern is to meet discharge requirements. Plant managers are risk adverse and are very conservative when considering any changes to plant equipment and operations. Energy conservation, when considered at all, is often of secondary importance. Because electrical motors are such a small part of the total cost structure, the managers are much more focused on meeting environmental standards, making it difficult to consider energy efficiency.

Impact of New Technologies:

- New membrane technologies have the potential for reducing energy in wastewater treatment using a vacuum pull-through membrane, replacing pump pressure.

- Use of small bubble bio-treatment reduces pump energy required over conventional aeration treatment.

Conclusion:

The water and wastewater industry has many opportunities for motor energy savings because of the large number of pump drive motors – many of which are large hp and many are old. Replacement could bring substantial savings. Furthermore, potential technical opportunities exist in ASDs on variable delivery situations and technical improvements in aeration. The industry is largely regulated and this does reduce the incentive for making energy saving changes to plants.

Sources Used:

Efficiency Strategies: "Energy-Efficient Motors" – California Energy Commission.

American Water Works Association, "Energy Management Opportunities" Journal; Denver; Feb 1998, Harish Arora.

Idaho Department of Water Resources, Energy Division, "Energy-Efficient Motors: A Study of their Application in Idaho Municipal Water Supply Systems," Scott King, July 1993.

Idaho Department of Water Resources, Energy Division, "Potential for the Use of Energy-Efficient Motors in Idaho Agriculture."

Journal of Energy Engineering, "Improved Operation of Water Distribution Systems Using Variable-Speed Pumps," Don Wood, Dec 1998.

Water Engineering and Management, "Control Systems: Packaged Controls Drive Water Plant Pumps," Jim Crawford, Jan 1999.

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Reference USA – http://reference.infousa.com/

5.6 Food and Kindred Products
(SIC 20)

Overview of Sector Motor Energy

Food and Kindred Products					
		National Motor	Pacific Northwest		
		Energy Use	Motor Energy Use		% of National
SIC	Segment	(GWh)	(GWh)	(aMW)	
20	Food and Kindred Products	51,919	2,747	314	5.3%
2011	Meat Packing	3,484	163	19	4.7%
2033	Canned Fruits and Vegetables	1,593	66	8	4.1%
2037	Frozen Fruits and Vegetables	2,582	628	72	24.3%
2051	Bread and Cake Products	1,748	71	8	4.1%
2063	Beet Sugar	400	79	9	19.8%
2082	Malt Beverages	2,504	140	16	5.6%
20xx	Other	39,608	1,600	183	4.0%
		PNW Motor Use (Units)			
SIC	Segment	Motors in Place	Annual Sales		
20	Food and Kindred Products	62,247	8,647		

		Motor Energy Use (GWh)			
SIC	Segment	Idaho	Montana	Oregon	Washington
20	Food and Kindred Products	634	100	793	1220
2011	Meat Packing	46	5	13	99
2033	Canned Fruits and Vegetables	4	0	16	45
2037	Frozen Fruits and Vegetables	233	0	140	255
2051	Bread and Cake Products	3	9	15	44
2063	Beet Sugar	41	12	26	0
2082	Malt Beverages	5	4	60	71
20xx	Other	302	70	522	705

		Motor Energy Use (GWh)			
SIC	Segment	Idaho	Montana	Oregon	Washington
20	Food and Kindred Products	634	100	793	1220
2011	Meat Packing	46	5	13	99
2033	Canned Fruits and Vegetables	4	0	16	45
2037	Frozen Fruits and Vegetables	233	0	140	255
2051	Bread and Cake Products	3	9	15	44
2063	Beet Sugar	41	12	26	0
2082	Malt Beverages	5	4	60	71
20xx	Other	302	70	522	705

		Motors in Place (units)			
SIC	**Segment**	**Idaho**	**Montana**	**Oregon**	**Washington**
20	Food and Kindred Products	13,168	2,676	17,224	29,179
		Motor Energy by Application			
SIC	**Segment**	**Fans**	**Pumps**	**Compressors**	**Other**
20	Food and Kindred Products	16%	16%	8%	68%

Description of Market

Major Industry Trends:

- The industry has grown nationally at 4% per year in dollar terms.

- The food industry is extremely competitive due to the large number of firms and the commodity nature of the market. It has historically had low profit margins, which significantly impacts investment decisions, holding back capital investment.
    - Much of available investment supports new product development.

- Most of the industry's growth comes from exports. It has the second highest value of export shipments of all industry and exports have been growing at over 3.5% annually in dollar terms recently.

- Foods requiring higher energy processing (foods fortified with extra nutrients and pre-prepared meals) have become increasingly popular in both domestic and foreign markets.

Relation of Regional Market to National Market:

- The Pacific Northwest accounts for 4% of the national value of shipments.

- The PNW tends to reflect general national market trends**,** but exports are a higher percentage.

- Frozen Fruits and Vegetables (2037) and Beet Sugar (2063) in the PNW constitute a significant share of national energy use of these segments at 27% and 23% of their SIC's respectively.

- There are many plant types in the region:
    1. Process plants – 12 month operation (e.g., potatoes).
    2. Process plants – seasonal operation.
    3. Finished products (e.g., cookies).
    4. Cold processing of frozen fruits and vegetables.
    5. Specialized – dairy, bakery, beverage, etc.
    6. Cold storage.

Profiles of Key Manufacturing Locations:

			Number of	
			Production	
Company	**City, State**		**Employees**	**Facility**
Amalgamated Sugar Co	Paul	Idaho	500	HQ + Plant
Armour Food Co	Nampa	Idaho	525	Plant
Basic American Foods	Blackfoot	Idaho	749	Plant
Idaho Potato Packers Inc	Blackfoot	Idaho	550	Plant
J R Simplot Co	Caldwell	Idaho	800	Plant
J R Simplot Co	Heyburn	Idaho	700	Plant
Seneca Foods Corp	Buhl	Idaho	800	Plant
Agripac Inc	Eugene	Oregon	675	HQ + Plant
Agripac Inc	Salem	Oregon	500	Plant
Agripac Inc	Woodburn	Oregon	800	Plant
Heikes Produce Inc	Cornelius	Oregon	600	HQ + Plant
J R Simplot Co	Hermiston	Oregon	800	Plant
Norpac Foods Inc	Salem	Oregon	712	HQ + Plant
Norpac Foods Inc	Salem	Oregon	800	Plant
Norpac Foods Inc	Stayton	Oregon	5000	Plant
Ore-Ida Foods Inc	Ontario	Oregon	900	Plant
Reser's Fine Foods Inc	Beaverton	Oregon	840	HQ + Plant
Truitt Brothers Inc	Salem	Oregon	700	HQ + Plant
Del Monte Corp	Yakima	Washington	850	Plant
IBP Inc	Wallula	Washington	1500	Plant
Independent Food Processors	Sunnyside	Washington	575	HQ + Plant
J R Simplot Co	Quincy	Washington	800	Plant
Lamb Weston	Richland	Washington	500	Plant
Snokist Growers	Yakima	Washington	900	HQ + Plant
Lamb Weston Inc.	Hermiston	Oregon		
Lamb Weston Inc.	Kennewick	Washington		
Oregon Turkey	Salem	Oregon		
Tillamook Creamery	Tillamook	Oregon		
Twin City Foods	Ellensburg	Washington		

Motor Energy Use:

- Food and kindred industries rank high on indices of the economic impact of energy costs and on the impacts of motor system use; the sector ranks fourth in total energy costs and in net electric demand; third in total motor systems electric use and motor system electric cost; and tenth in motor system energy costs as a percent of operating costs.

- Although the impact of motor savings on operating income is relatively less in the food industry, the effect on profitability of efficiency improvements in this low profit margin industry can represent a large competitive advantage.

- Processing (motor use) uses 78% of electricity, with 48% used for machine drive and 25% for process cooling and refrigeration.

- Frozen Fruits and Vegetables (2037) uses the most motor energy in the PNW with Meat Packing (2011) and Malt Beverages (2082) coming in a distant second and third.

- The penetration of ASD motors is very high in the food industry, although they control a disproportionately small amount of the electricity consumed by the sector.

- The canning industry (non-cold processing) has motors running year round, but uses comparatively smaller motors.

- 9% of motors meet EPAct standards.

- 21% of motors are equipped with ASDs.
    - 10% of energy is under ASD control.

- Average part load is 61% (manufacturing average is 62%).

- 31% of energy is used in motors of greater than 200 horsepower.

Expert observers have identified the following areas:

- The cold storage and processing of fruits and vegetables consumes a considerable amount of energy in the refrigeration and cooling process and is a major potential savings area. These systems have been designed to lower first cost of the installation and there are many upgrade opportunities.
    - Sizing and upgrading of drive motors.
    - ASD's on variable load pieces of equipment such as compressors, evaporator fans, and condenser fans.
    - Lower pressure in cooling tower suction pressures.
    - Ammonia systems with floating head pressure control.
    - Water cooling replacing air.

- Motor energy savings in food processing, through upgrading smaller-sized pumps and correctly sizing and upgrading all pump drives, is substantial.
    - Fractional horsepowers may be an opportunity, especially in finished product plants (such as cookies) for conveyors and fans.

- The yearlong processing of foods such as potatoes, uses many small motors for conveying.
    - This may be an opportunity for savings with motor upgrades.

- Experts say that many motors are oversized and that the proper sizing of motors could yield significant savings.

Summary of Savings Potential:

- Motor systems upgrades.
    - There are clear opportunities for installation of more efficient motors, particularly in the cold storage facilities.

- Pump systems improvement.
    - Opportunities for installing better pump upgrade drives and use of ASDs throughout the industry.

- Air Compressor systems.
    - Significant savings are possible from improved system design.

- Refrigeration system.
    - The principal major opportunity in the region from system upgrade through improved control, better refrigerants, etc.

Summary of Savings Potential:

		Savings Potential	
	National	Pacific Northwest	
Type of Savings	**GWh/year**	**GWh/year**	**Percent**
Motor Efficiency Upgrade	2,280	173	31%
Rewind Improvements	295	21	4%
Motor Downsizing	585	43	8%
Pump System Improvements	1,250	91	16%
Fan System Improvements	157	11	2%
Air Compressor Systems Improvement	494	36	6%
Refrigerant Systems Improvements	517	180	32%
Total:	5,578	562	100%
Total Motor Energy	37,797	2,747	
Percent Savings Potential	12%	21%	
Percent of National Industry Savings			7%

Possible Barriers to Energy Efficiency:

- Seasonal food processing plants typically run only 1300 hours a year, although they may have as many as 700 to 800 motors running at full capacity when in use. Low hours of use makes justification of higher cost, more efficient equipment, difficult.

- Most of the contractors supplying equipment to the industry (e.g., refrigeration), as well as process design engineers in food processing spend little time on energy efficiency.

New Technologies with Opportunities for Energy Efficiency Improvement:

- Replacement of pasteurization and sterilization by cold pasteurization and electron beam sterilization can reduce the use of refrigeration, although the acceptance of these technologies has been slow.

- Replacement of evaporation and concentration by supercritical extraction and protein separation have selective potential.

- Mechanical vapor recompression -- Replacement of thermal drying by vapor recompression supercritical extraction drying. – possible savings of 21 to 58% with simple payback time of 1 to 4.5 years. Would substitute motor energy for direct heating.

- Freeze Concentration -- Product chilling, cooling and refrigeration by controlled atmosphere packaging.

- Membrane Separation – Could improve overall efficiency without adding to electrical loads and offer environmental benefits.

<u>Conclusions</u>:

The major target in the food processing industry is the refrigeration systems for cold processing. These systems are typically purchased on a first cost basis and do not use energy efficient drives and systems. There are many opportunities for upgraded motors and better controls on fans, compressors, and other system changes. However many of the improvements require refrigeration system changes beyond motor systems.

The industry also uses a large number of process pumps and observers report opportunities for energy savings in downsizing and control.

The food industry is reported not to be energy conscious and the large number of seasonal plants present barriers.

There is need to gain a better understanding of the Other segment of SIC 20 that represents over half of this sector's motor energy use.

Sources Used:

ACEEE, "Energy Usage in the Food Industry" by Dr. Martin Okos, et al. October 1998.

DOE Office of Industrial Technologies (Xenergy the contractor), "United States Industrial Electric Motor Systems Market Opportunities Assessment."

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Personal communication – John Johnson, Xenergy.

5.7 Lumber and Wood Products (SIC 24)

Overview of Sector Motor Energy

Lumber and Wood Products		National	Pacific Northwest		
		Energy Use	Energy Use		% of National
SIC	Segment	(GWh)	(GWh)	(aMW)	
24	Lumber and Wood Products	16,575	2,865	327	17%
2421	Sawmills and Planing	5,911	1,212	138	21%
2436	Softwood Veneer and Plywood	2,277	915	104	40%
2493	Reconstituted Wood	3,731	292	33	8%
24xx	Other	4,656	446	51	10%
		PNW Motor Use (Units)			
SIC	Segment	Motors in Place	Annual Sales		
24	Lumber and Wood Products	83,778	13,242		

		Motor Energy Use (GWh)			
SIC	Segment	Idaho	Montana	Oregon	Washington
24	Lumber and Wood Products	332	181	1,779	573
2421	Sawmills and Planing	234	116	517	344
2436	Softwood Veneer and Plywood	22	0	820	73
2493	Reconstituted Wood	13	39	234	7
24xx	Other	61	26	209	150

		Motors in Place (units)			
SIC	Segment	Idaho	Montana	Oregon	Washington
24	Lumber and Wood Products	11,578	5,400	43,379	23,422
		Motor Energy by Application			
SIC	Segment	Fans	Pumps	Compressors	Other
24	Lumber and Wood Products	12%	6%	8%	74%

Description of Market

Major Industry Trends:

- The national value of shipments is growing at a compounded annual growth rate of 4%.
- Construction and building is the primary market for Lumber and Wood Products.
    - Construction and building markets have historically been volatile, although demand in the past eight years has been steadily increasing.
    - Total national shipments of lumber and wood products are near $100 billion.

- Exports increased from $3 billion to $7.3 billion from 1986 to 1996 but have risen more slowly since at 3% per year.
    - Domestic shipments have only increased by 2%.
    - Imports growing faster than exports.

- Reconstituted wood products is the fastest growing product category.

Relationship of the Regional Market to the National

- The Pacific Northwest represents about 25% of the national value of shipments.

- Timber sales in PNW of federal lands have been substantially curtailed from 26 million cubic feet felled in 1988 to 4 million cubic feet currently, largely through government restrictions on lumbering and increased imports.

    - Smaller companies especially depend on federal land for timber.
    - As a result, saw mills are under pressure and many are closing.
    - 70% of timber comes from federal lands.

- The regional trend is moving towards more secondary work on wood and less plain lumber.

Profiles of Key Manufacturing Locations:

Company	City	State	Production Employees	Facility
T J International	Boise	Idaho	200	HQ + Plant
Trus Joist MacMillan	Boise	Idaho	3,000	Plant
Woodgrain Millwork Inc.	Fruitland	Idaho	750	HQ + Plant
Bright Wood Corp.	Madras	Oregon	1,200	HQ + Plant
Crown Pacific Partners LP	Portland	Oregon	1,200	Plant
Weyerhaeuser Co	Springfield	Oregon	1,000	Plant
Louisiana Pacific Corp.	Portland	Oregon	10	Plant
Rosenburg Forest Products	Dillard	Oregon	2,741	HQ + Plant
Tree Source Industries Inc.	Portland	Oregon	1,100	HQ + Plant
RSG Forest Products Inc.	Clatskanie	Oregon	136	HQ + Plant
Willamette Industries Inc.	Warrenton	Oregon	144	Plant
Bohemia Dorena		Oregon		
Bohemia Drain		Oregon		
Boise Cascade Co	Lagrande	Oregon		
Multnomah Plywood	St. Helens	Oregon		
Weyerhaeuser Co	Cottage Grove	Oregon		
Willamette Industries Inc.	Lebannon	Oregon		
Cascade Hardwood	Chehalis	Washington		
Simpson Door Co	McCleary	Washington		
Weyerhaeuser Co	Four Plants	Washington		

Total Motor Energy Use:

- Wood moving and handling devices are the major energy users. These include: choppers, log handling, board handling, presses, etc.

- Pneumatic conveying of wood chips and sawdust are substantial users.

- Wood kiln drying is a major fan use.

Expert observers have identified the following areas for motor energy savings:

- The industry uses many specialty motors, particularly for product conveying. Many are DC. Opportunities for use of ASD controlled AC are possible in some cases.

- Many specialty motors used are likely to be rewound rather than a new motor purchase which would be special order.

- Improvement of control of kiln furnace fans are a major opportunity for efficiency improvements. ASDs on the fan drive, tied to moisture sensing, has already been installed on many kilns.

- Using ASDs on the induced draft fan and/or the forced air fan for boilers air can improve motor drive efficiency and improve boiler performance.

- ASD drives for debarkers at sawmills.

- Switch to radial type induced draft fans to allow reduction of the horse power used in dust collection.

- Using fans rather than compressed air to clean off sawdust from equipment.

Savings Potential:

- Motor systems upgrades
    - Upgrade to higher efficiency motor.

- Rewind improvements
    - Improvement in rewind process control on the many specialty motor rewinds.

- Fan systems improvement
    - Installation of ASDs on kiln fans.
    - Use of ASDs on pneumatic conveyors tied to demand.

- Air compressor improvements
    - Improvement in air compressor system design, control.

- Other system improvements
    - Use of ASD on material movement devices, replacing DC motors and better control of AC.

Summary of Savings Potential:

	National	PNW	
Type of Savings	**GWh/year**	**GWh/year**	**Percent**
Motor Efficiency Upgrade	432	75	21%
Rewind Improvements	184	32	9%
Motor Downsizing	336	58	17%
Pump System Improvements	243	42	12%
Fan System Improvements	153	26	8%
Air Compressor Systems Improvements	324	56	16%
Other Systems Improvements	341	59	17%
Total:	2,013	348	100%
Total Motor Energy	16,575	2,865	
Percent Savings Potential	12%	12%	
Percent of National Industry Savings			17%

Possible Barriers to Energy Efficiency:

- The poor financial state of much of the industry prevents many companies from investment in energy saving efficiency.

Conclusions:

There are a number of possible motor energy saving opportunities in the lumber and wood products industry. The industry is in poor financial health and there have been severe reductions in the allowed woodcutting. As a result, the industry in general is much less receptive to investment for energy savings.

Sources Used:

DOE Office of Industrial Technologies (Xenergy the contractor), "United States Industrial Electric Motor Systems Market Opportunities Assessment."

Department of Commerce, "U.S. Industry and Trade Outlook '98."

Reference USA – http://reference.infousa.com/

Personal Communication – Bill Welch, Eugene Power.

5.8 Petroleum and Coal Products (SIC 29)

Overview of Sector Motor Energy

		Motor Energy Use (GWh)			
SIC	**Segment**	**Idaho**	**Montana**	**Oregon**	**Washington**
29	Petroleum and Coal Products	19	407	68	986
2911	Petroleum Refining	14	404	5	937
	Other	5	3	64	50
		Motors in Place (units)			
SIC	**Segment**	**Idaho**	**Montana**	**Oregon**	**Washington**
29	Petroleum and Coal Products	569	4,839	4,794	14,336
		Motor Energy by Application			
SIC	**Segment**	**Fans**	**Pumps**	**Compressors**	**Other**
29	Petroleum and Coal Products	10%	59%	15%	16%

		National	Pacific Northwest		
		Energy Use	**Energy Use**		**% of National**
SIC	**Segment**	**(GWh)**	**(GWh)**	**(aMW)**	
29	Petroleum and Coal Products	44,316	1,481	169	3%
2911	Petroleum Refining	40,805	1,360	155	3%
	Other	3,511	121	14	3%
		PNW Motor Use (Units)			
SIC	**Segment**	**Motors in Place**	**Annual Sales**		
29	Petroleum and Coal Products	24,536	2,938		

Description of Market

Major Industry Trends:

- Petroleum and Coal Products industries are extremely capital intensive, particularly the major segment – petroleum refining.
- U.S petroleum refining has grown by 2% annually in value of shipments in recent years.
- The U.S. refining industry is the third largest in the world, accounting for 21 percent of global refining capacity.
- Increases in environmental costs combined with declining quality of crude oil imports has led to increased investment requirements per unit of refined product.

Relation of Regional Market to National Market:

- The PNW tends to reflect general national market trends**.**
- The PNW has about 3% of the national oil refining capacity.

Profiles of Key Manufacturing Locations:

				Number of	
				Production	
	Company	**City**	**State**	**Employees**	**Facility**
	Cenex	Laurel	Montana	250	Plant
	Conoco Inc. Refinery	Billings	Montana	300	Plant
	Atlantic Richfield Co	Blaine	Washington	465	Plant
	US Oil & Refining Co	Tacoma	Washington	150	Plant
	British Petroleum Refining	Ferndale	Washington		
	Chevron		Idaho		
	Sound Refining Co	Tacoma	Washington		

Energy Efficiency

Total Motor Energy Use:

- The petroleum industry ranks very high on indices of the economic impact of energy costs, particularly in terms of electric motor use per establishment: first in energy costs per establishment, first in motor systems electric use as a percentage of total electric use, and first in motor system energy costs per establishment.
- Petroleum refining has a very high ratio of energy consumption to value of shipments.
- This sector has a higher reliance on large (greater than 200 hp) motors.
- The penetration rates for EPAct compliant and ASD motors are moderate, but the amount of energy used by motors with ASDs is low.
- 8% of motors meet EPAct standards.
- 5% of motors are equipped with ASDs.
- ASDs control 1% of motor energy.
- Average part load is 59% (manufacturing average is 62%).
- 55% of energy is used by motors with greater than 200hp.

Opportunities for Energy Efficiency Improvements:

- The PNW has a small share of U.S. refining capacity and only a handful of refineries, but each plant is energy intensive.

- Several refineries in Montana and Washington participate in their company's national blanket agreements with the motor manufacturers. They also draw upon their internal corporate technical resources.

- The largest amount of potential motor savings is in improving the efficiency of pump systems, as pumps represent 60% of the motor-driven equipment. Obtaining these savings requires site-specific systems redesign.

- Upgrading larger motors can also yield savings.

Savings Potential:

- Motor systems upgrades
  - Some opportunity because of the number of very large motors.

- Rewind improvements
  - Some opportunity because of the number of very large motors.

- Pump systems improvement
  - Pumps represent 60% of motor energy use, and improvement of these systems is the major opportunity in the industry.

Summary of Savings Potential:

	National	PNW	
Type of Savings	**GWh/year**	**GWh/year**	**Percent**
Motor Efficiency Upgrade	2873.00	82	24%
Rewind Improvements	453.00	13	4%
Motor Downsizing	459.00	13	4%
Pump System Improvements	6159.00	176	52%
Fan System Improvements	271.00	8	2%
Air Compressor Systems Improvements	1352.00	39	12%
Other Systems Improvements	169.00	5	1%
Total:	11736.00	335	100%
Total Motor Energy	51938.00	1481	
Percent Savings Potential	20%		
Percent of National Industry Savings			3%

Possible Barriers to Energy Efficiency:

- Petroleum refineries are highly engineered continuous process plants. Changes to motors and drives for energy efficiency must be engineered as part of the process, and as a result obtaining these energy savings is costly.

Conclusions:

The petroleum and coal products industry, primarily petroleum refineries, is a large consumer of electricity. Much of this is concentrated in drives for pumps with opportunity for better pump speed control (e.g. ASDs) and upgrade of the many large motors. However, the PNW has a very small share of the national capacity and only a few plants, making regional opportunity modest. This industry has substantial engineering resources at headquarters that is available to the plants.

Sources Used:

U.S. Department of Commerce, Bureau of the Census "Statistical Abstract of the United States 1998: The National Data Book"

DOE Office of Industrial Technologies (Xenergy the contractor), "United States Industrial Electric Motor Systems Market Opportunities Assessment."

Reference USA – http://reference.infousa.com/

Personal Communication: Bob Zbedski, Hunt Technologies.

5.9 Semiconductor Fabrication
(SIC 3674)

Overview of Sector Motor Energy

		Pacific Northwest			
		Energy Use		Motors in Place (Units)	Annual Sales
SIC	Segment	(GWh)	aMW		(Units)
3674	Semiconductor Fab	1,250	143	5,830	1,117

		Motor Energy Use (GWh)			
SIC	Segment	Idaho	Montana	Oregon	Washington
3674	Semiconductor Fab	264	66	655	264

		Employment			
SIC	Segment	Idaho	Montana	Oregon	Washington
3674	Semiconductor Fab	833	26	5,173	3,398

		Motor Energy by Application			
SIC	Segment	Fans	Pumps	Compressors	Other
3674	Semiconductor Fab.	50%	20%	20%	10%

Description of Market

Major Industry Trends:

- The largest segment of the electronics industry is semiconductor products.
- The U.S. semiconductor industry is a very large $60 billion per year business; it is growing rapidly at 8 to 10% per year and represents about a third of global production.
- The industry is globally oriented with most participants manufacturing in many parts of the world.
- The industry invests in plant and equipment, nearly 14% of revenues per year vs. 3% for all U.S. industry.
- National employment in the semiconductor industry is 190,000 and expected to grow by 40% in the next 5 years.

- Fabrication manufacturing line life is short, two to four years on average, because of rapid product obsolescence. When product changes, plants go through major renovation.

Relation of Regional Market to National Market:

- Large microelectronics companies, particularly Intel and Hewlett-Packard, have set up lower level skill factories in the Pacific Northwest while keeping their corporate headquarters and most sophisticated plants in Northern California.

- In 1994 microelectronics provided 13.5 percent of Oregon's corporate taxes, in 1984 it was only 3.6 percent.

- The PNW has about 4.5% of the industry's employment.

Profiles of Key Manufacturing Locations[1]:

			Number of	
			Production	
Company	**City**	**State**	**Employees**	**Facility**
American Microsystems Inc.	Pocatello	Idaho	1,100	Plant
Micron Technology Inc.	Boise	Idaho	8,000	HQ + Plant
Zilog	Boise	Idaho		Plant
Semitool Inc.	Kalispell	Montana	1,025	HQ + Plant
Advanced Silicon Materials		Montana		
Fujitsu Microelectronics Inc.	Gresham	Oregon	1,000	Plant
Intel Corp	Hillsboro	Oregon	6,300	Plant
Merix Corp	Forest Grove	Oregon	1,572	HQ + Plant
Mitsubishi Silicon America	Salem	Oregon	1,100	HQ + Plant
Praegitzer Industries Inc.	Dallas	Oregon	2,000	HQ + Plant
Siltec Epitaxial	Salem	Oregon		
Wacker Siltronic Corp	Portland	Oregon	1,450	HQ + Plant
Tektronix	Beaverton	Oregon		HQ + Plant
Hewlett Packard	Corvalis	Oregon		Plant
Hyundai	Eugene	Oregon		Plant
LSI Logics	Gresham	Oregon		Plant
Komatsu Silicon		Oregon		
Komatsu Metals		Oregon		
Mitsubishi Silicon America		Oregon		
Fujitsu		Oregon		
Integrated Device Technology		Oregon		
Triquint		Oregon		
Epson		Oregon		
Planar		Oregon		
Sequent		Oregon		
Sharp		Oregon		
Interactive Systems		Oregon		
Eldec Corp	Lynnwood	Washington	1,128	Plant
Johnson Matthey Electronics	Spokane	Washington	1,200	Plant
Wafertech	Vancouver	Washington		Plant
SEH America	Vancouver	Washington		Plant
Linear Technology	Vancouver	Washington		Plant
Siemens Solar Industries		Washington		

[1] The list includes microelectronics plants that also utilize “clean rooms” but may not be classified under SIC 3674

Energy Use

- The typical semiconductor fabrication plant consumes 83 GWh/year (9.5 aMW) in total motor energy.

- The energy use is divided between manufacturing equipment, 40% and HVAC, 60%.
  - Air handling 28%
  - Chillers 20%
  - Pumps 12%

Opportunities for Energy Efficiency Improvements:

- The principal opportunity for motor energy savings is in improving the environmental control systems in the clean rooms. This can be achieved by:
  - Redesign of air flow and chilled water systems.
  - ASD controls on pumps circulating chilled water, the compressors, and air handling equipment.

- There is some minor potential for motor upgrade and management.

- Some experts see potential savings of over 30% in existing plants and possibly 50% to 70% in a new plant design.

Savings Potential:

- Motor systems upgrades
  - Some minor potential
- Pump systems improvement
  - Some potential in chilled water distribution
- Fan systems improvement
  - The major potential through air handling systems redesign and control
- Air compressor improvements
  - Some potential
- Other system improvements
  - Compressor improvements

Summary of Savings Potential:

	PNW	
Type of Savings	**GWh/year**	**Percent**
Motor Efficiency Upgrade	40	21%
Rewind Improvements	6	3%
Motor Downsizing	15	8%
Pump System Improvements	30	15%
Fan System Improvements	50	25%
Air Compressor Systems Improvements	20	10%
Other Improvements	31	15%
Total:	192	100%
Total Motor Energy	1,250	
Percent Savings Potential		15%

Barriers to Motor Energy Efficiency:

- The useful life of a plant is only two or three years and engineers design for a short payback period. The structure of the facility has a life of closer to 15 years, and the HVAC and other environmental equipment is usually retained with product line changed.

- Motor efficiency improvements in the HVAC system and elsewhere must be installed as the plant is being designed or retooled for a new product.

- Plant design of a new plant, or a retooling focuses on rapid start up of new product production line; energy is viewed as a smaller, fixed cost and does not get much attention.

New Technologies with Good Opportunities for Energy Efficiency Improvement:

- High efficiency (80-90%) axial air-foil fans with direct drive and static regain devices are said to have important potential.

Conclusions:

The semiconductor industry in the PNW is sizeable and rapidly growing. The use of motor energy is significant, particularly in environmental control systems. Redesign of air handling and cooling water refrigeration and circulation have potential. However, short product life causes rapid plant obsolescence and short-term design horizons. This greatly reduces the incentive for energy savings investment, except in new plant construction.

Sources Used:

DOE Office of Industrial Technologies (Xenergy the contractor), "United States Industrial Electric Motor Systems Market Opportunities Assessment."

"Which Way to Silicon Forest?" Michael Malone, March 1996.

Microelectronics Facility Efficiency Workshop – Meeting Report and Appendices, Northwest Power Planning Council, December, 1995.

"Even Non-investors benefit from Silicon Forest's surge," Business Journal-Portland – November 1997, Dan McMillan.

"Opportunities for Efficiency in the Northwest Microelectronics Industry" – Bonneville Power Administration, Northwest Power Planning Council, Oregon Office of Energy.

Reference USA -- http://reference.infousa.com/

Personal Communications – Doug Findley and Gary Mitchel at Portland General Electric.

5.10 Primary Metals
(SIC 33)

Overview of Sector Motor Energy

		National	Pacific Northwest		
		Energy Use	Energy Use		
SIC	Segment	(GWh)	(GWh)	(aMW)	% of National
33	Primary Metals	50,795	1,262	144	2%
3312	Steel	26,834	420	48	2%
3334	Primary Aluminum	1,950	383	44	20%
3353	Aluminum Sheeting	3,897	13	1	0%
	Other	18,114	446	51	2%
		Motor Energy Use (GWh)			
SIC	Segment	Idaho	Montana	Oregon	Washington
33	Primary Metals	12	101	557	592
3312	Steel	2	11	265	143
3334	Primary Aluminum	0	61	66	256
3353	Aluminum Sheet	0	0	0	13
	Other	11	28	225	181
		Motors in Place (units)			
SIC	Segment	Idaho	Montana	Oregon	Washington
33	Primary Metals	214	1,052	6,085	6,096
		Motors in Place (units)			
SIC	Segment	Idaho	Montana	Oregon	Washington
33	Primary Metals	31	153	882	884
		Motor Energy by Application			
SIC	Segment	Fans	Pumps	Compressors	Other
33	Primary Metals	15%	9%	14%	62%

Description of Market

Major Industry Trends:

- Primary Metals is a mature industry which competes in a global market. This puts continual pressure on U.S. companies to reduce costs.
  - The primary metals industry has grown at 3% annually in the last ten years.
- The domestic steel industry has made significant strides in reducing cost in the past decade, and is now among the lowest-cost producers in the world. However, the industry is continually under the threat of low-priced foreign imports.

The industry continues to direct most of its R&D spending on developing new technologies to reduce costs, particularly steel.

Relation of Regional Market to National Market:

- The Pacific Northwest represents 3% of the national value of shipments.

- The PNW primary metal industry is heavily concentrated in basic aluminum which has been attracted to the region by the low electric rates.

- The region also has several electric arc, basic steel plants, which take advantage of low power rates.

- A small number of metal fabricating plants also operate in the region – sheet rollers foundries, pipe mills, die casters, etc., but are a small portion of the national industry.

Profiles of Key Manufacturing Locations:

			Number of	
			Production	
Company	**City**	**State**	**Employees**	**Facility**
Columbia Falls Aluminum	Columbia Falls	Montana		
Esco Corp	Portland	Oregon	2,500	HQ + Plant
Northwest Pipe Co	Portland	Oregon	1,000	HQ + Plant
Oregon Steel Mills Inc.	Portland	Oregon	2,426	HQ + Plant
PCC Structurals Inc.	Portland	Oregon	1,700	Plant
Precision Castparts Corp.	Portland	Oregon	10,367	HQ + Plant
Dow Corning	Springfield	Oregon		
Dow Corning	Springfield	Oregon		
Northwest Aluminum	The Dalles	Oregon		
Reynolds Metals	Troutdale	Oregon		
Glenbrook Nickel	Riddle	Oregon		
Gilmore Steel		Oregon		
Oregon Metallurgical		Oregon		
Kaiser Aluminum and Chemical	Mead	Washington	1,107	Plant
Kaiser Aluminum and Chemical	Spokane	Washington	1,400	Plant
Salmon Bay Steel	Seattle	Washington		
Seattle Steel Inc.	Seattle	Washington		
Alcoa	Wenatchee	Washington		
Columbia Aluminum	Goldendale	Washington		
Alumax	Ferndale	Washington		
Kaiser Aluminum	Tacoma	Washington		
Kaiser Aluminum	Trentwood	Washington		
Reynolds Metals	Longview	Washington		
Vanalco	Vancouver	Washington		
Alcoa-Northwest Alloys	Addy	Washington		
ACPC	Vancouver	Washington		

Energy Efficiency

Total Motor Energy Use:

- The Primary Metals industries rank very high on indices of economic impact of energy costs:
  - First in energy costs as a percent of operating costs.
  - Fourth in total motor systems electric use.
  - Seventh in motor system energy costs as a percent of operating costs.
- The majority of sector energy is consumed by two industry subgroups: Electric arc steel mills (3312) and primary aluminum (3334). Both are huge users of electric energy, but most of this is not motor energy.
- The penetration rates of EPAct compliant and ASD motors are relatively low.
- The industry uses many large motors and the number greater than 200 HP is very high.
  - The use of DC motors is very high in the primary metals industry for product feed, sheet metal rolling, electric arc electrode control.
  - Aluminum plants have many process pumps and fans.
  - The aluminum industry in the PNW purchases the electricity as a direct service customer under extremely low electric rates.
- 3% of motors meet EPAct standards.
- 4% of motors are equipped with ASDs.
- ASDs control 6% of motor energy.
- Average part load is 57% (manufacturing average is 62%).
- 58% of energy is used by motors with over 200 hp.

Experts See Opportunities for Energy Efficiency Improvements in:

- Steel industry has decreased energy intensity from its peak --17%. (11% is due to efficiency improvements.)
  - The potential for improvements in energy efficiency in the U.S. is still higher than in other OECD countries.

- Electricity savings from upgrade to efficient motors can yield the highest motor energy savings for the industry.

- There are some opportunities in dust collection systems through putting in ASD controlled fans tied to demand.

- Experts say that metal fabrications such as die casters and foundries have little opportunity besides compressed air.

Savings Potential:

- Motor systems upgrades.
  - Most of the sector energy savings are in motors systems upgrade due to the number of large motors and low penetration of higher efficiency motors.

- Rewind improvements.
  - Some opportunity for better rewind quality.

- Pump systems improvement.
  - Some opportunity in cooling water and other pump systems.

- Fan systems improvement.
  - Some opportunities in dust collection systems, exhaust control.

- Air compressor improvements.
  - A number of opportunities in metals fabricating plants.

Summary of Savings Potential:

		PNW	
Type of Savings	**National GWh/year**	**GWh/year**	**Percent**
Motor Efficiency Upgrade	5,303	76	42%
Rewind Improvements	749	11	6%
Motor Downsizing	983	14	8%
Pump System Improvements	1,537	22	12%
Fan System Improvements	738	11	6%
Air Compressor Systems Improvements	2,150	31	17%
Other Systems Improvements	1,085	16	9%
Total:	12,545	180	100%
Total Motor Energy	87,935	1,262	
Percent Savings Potential	14%	14%	14%
Percent of National Industry Savings			1.4%

Possible Barriers to Energy Efficiency:

- The primary aluminum plants purchase power as a direct service customer and as a result, pay very low rates. This reduces economic incentive for motor energy saving efforts.

- Steel and aluminum mills have many motors used in such operations as plate and sheet rolling, but they are used intermittently to control the process with overall low capacity utilization.

Conclusions:

The primary metals industry nationally has major opportunities for motor energy saving, but the industry in the PNW has far fewer. The basic aluminum, and to some extent the steel (electric arc) producers, have been drawn to the region by low power costs and many plants are served as DCI customers. This reduces the financial incentive for motor energy savings investment. There are, however, a few opportunities in metal fabrication operations, motors upgrade the principal one.

Sources Used:

U.S. Department of Commerce, Bureau of the Census "Statistical Abstract of the United States 1998: The National Data Book."

DOE Office of Industrial Technologies (Xenergy the contractor), "United States Industrial Electric Motor Systems Market Opportunities Assessment."

Reference USA – http://reference.infousa.com/

Personal Communication – Gary Mitchell and Doug Findley, Portland General Electric.

6.0 Appendix

A. Motor Energy Use: National and PNW (Based on Employment Data)

B. Number of Motors by Size and Sector

C. Motor Energy by Size of Motor and Sector

D. Number of Motors by Application and Horsepower – for selected industries

E. List of NEEA Programs

F. Basis of Motor Energy Estimates

G. Targeting Standard vs Special Motors

APPENDIX A

Motor Energy Use: National and PNW (Based on Employment Data)

SIC 2 Digit	SIC 4 Digit	Industry	National Energy (GWh)	National Employment	National Use per Employee	PNW Employment	PNW Energy Use	Idaho Emp.	Idaho Energy (GWh)	Montana Emp.	Montana Energy (GWh)	Oregon Emp.	Oregon Energy (GWh)	Washington Emp.	Washington Energy (GWh)	Total 4 States Emp.	Total 4 States Energy (GWh)
26		Paper	103,992	621,000	0.17	30,194	5,056	492	82.4	695	116	10,538	1,765	18,469	3093	30194	5056
	2611	Pulp Mills	6,707	12,300	0.55	9,109	4,967	-	0.0	-	0	2,827	1,542	6,282	3425	9109	4967
	2621	Paper Mill	57,756	122,800	0.47	6,803	3,200	6	2.8	-	0	1,727	812	5,070	2385	6803	3200
	2631	Paperboard Mill	27,711	54,900	0.50	3,195	1,613	120	60.6	675	341	2,014	1,017	386	195	3195	1613
	26--	Other	11,818	431,000	0.03	11,087	304	366	10	20	1	3,970	109	6,731	185	11087	304
	26*	Modified Total					10,083		73		341		3,479		6,189		10,083
28		Chemical	143,056	824,000	0.17	16,582	2,879	3,858	669.8	776	135	3,346	581	8,602	1493	16582	2879
	2819	Industrial Inorganic	37,947	64,600	0.59	3,270	1,921	1,101	646.7	135	79	172	101	1,862	1094	3270	1921
	2869	Industrial Organic	-	89,300	0.00	380	-	16	0.0	45	0	74	-	245	0	380	0
	2873	Nitrogenous Fertilizers	3,884	8,000	0.49	421	204	35	17.0	2	1	72	35	312	151	421	204
	2874	Phosphatic Fertilizers	3,518	8,500	0.41	995	412	933	386.2	6	2	8	3	48	20	995	412
	28--	Other	97,707	653,600	0.15	11,516	1,722	1,773	265.0	588	88	3,020	451	6,135	917	11516	1722
	28*	Modified Total				-	4,259		1,315		171		591		2,182		4,259
						-	-										
20		Food and Kindred Products	51,919	1,511,500	0.0343	75,928	2,608	16,062	551.7	3,264	112	21,010	722	35,592	1223	75928	2608
	2011	Meat Packing	2,957	119,500	0.0247	6,575	163	1,844	45.6	184	5	539	13	4,008	99	6575	163
	2033	Canned Fruits and Vegetables	1,105	60,100	0.0184	3,577	66	199	3.7	18	0	897	16	2,463	45	3577	66
	2037	Frozen Fruits and Vegetables	2,311	47,700	0.0484	12,961	628	4,811	233.1	5	0	2,886	140	5,259	255	12961	628
	2051	Bread and Cake Products	1,639	159,000	0.0103	6,889	71	313	3.2	890	9	1,437	15	4,249	44	6889	71
	2063	Beet Sugar	351	8,100	0.0433	1,830	79	953	41.3	270	12	600	26	7	0	1830	79
	2082	Malt Beverages	1,876	33,500	0.0560	2,493	140	86	4.8	65	4	1,074	60	1,268	71	2493	140
	20--	Other	41,680	1,083,600	0.0385	41,603	1,600	7,856	302.2	1,832	70	13,577	522	18,338	705	41603	1600
	20*	Modified Total				-	2,747		634		100		793		1,220		2,747
						-	-										
24		Lumber and Wood	16,575	718,500	0.0231	93,180	2,150	12,877	297.1	6,006	139	48,247	1,113	26,050	601	93180	2150
	2421	Sawmills and Planing Mills	5,911	142,200	0.0416	29,146	1,212	5,646	234.7	2,793	116	12,433	517	8,274	344	29146	1212
	2436	Softwood Veneer and Plywood	2,277	30,300	0.0751	12,176	915	300	22.5	-	0	10,906	820	970	73	12176	915
	2493	Reconstituted Wood Products	3,731	24,100	0.1548	1,888	292	86	13.3	250	39	1,510	234	42	7	1888	292
	24--	Other	4,656	521,900	0.0089	49,970	446	6,845	61.1	2,963	26	23,398	209	16,764	150	49970	446
	24*	Modified Total				-	2,865		332		181		1,779		573		2,865
						-	-										
29		Petoleum and Coal Products	44,316	112,200	0.3950	3,798	1,500	88	34.8	749	296	742	293	2,219	876	3798	1500
	2911	Petroleum Refining	40,805	71,700	0.5691	2,389	1,360	25	14.2	710	404	8	5	1,646	937	2389	1360
	29--	Other	3,511	40,500	0.0867	1,399	121	53	4.6	39	3	734	64	573	50	1399	121
	29*	Modified Total				-	1,481		19		407		68		986		1,481
						-	-										
33		Primary Metal Industries	50,795	663,600	0.0765	17,632	1,350	280	21.4	1,379	106	7,979	611	7,994	612	17632	1350
	3312	Steel	26,834	156,100	0.1719	2,446	420	9	1.5	65	11	1,542	265	830	143	2446	420
	3334	Primary Aluminum	1,950	18,500	0.1054	3,630	383	-	0.0	580	61	625	66	2,425	256	3630	383
	3353	Aluminum Sheet	3,897	22,200	0.1755	74	13	-	0.0	-	0	2	0	72	13	74	13
	33--	Other	18,114	466,800	0.0388	11,482	446	271	10.5	734	28	5,810	225	4,667	181	11482	446
	33*	Modified Total				-	1,262		12		101		557		592		1,262
						-	-										
37		Transportation Equimpment	42,102	1,842,000	0.02	92,308	2,110	2,934	67	277	6	14,232	325	74,865	1711	92308	2110
	372	Aircraft and Parts	10,120	500,000	0.02	70,172	1,420	797	16	54	1	5,120	104	64,201	1299	70172	1420
1x		Mining	54,433	260,000	0.21	11,900	4,030	2,600	1286	4,100	2395	3,000	762	2,200	713	11,900	5,157
	10	Metal Mining	46,000	54,000	0.85	4,300	3,663	1,400	1193	2,200	1874	0	0	700	596	4,300	3,663
	14	Nonmetallic Minerals	8,433	108,000	0.08	4,700	367	1,200	94	700	55	1,300	102	1,500	117	4,700	367
		Modified Total				9,000	4,030	2,600	1286	2,900	1929	1300	102	2200	713	9,000	4,030
49		Water															
	4971	Irrigation	We did not use employment data to find the motor energy use in the PNW. For these sectors we used acres of land irrigated and gallons of water treated.						3,133		430		1,116		1,599		6,300
	4941,	Water Supply and															2,099
	4952	Wastewater Treatment															
	49*	Modified Total															
36		Electronics	We did not use national employment data to find the motor energy use in the PNW for microelectronics. Instead, with information from industry experts we estimated using number of plants, employees per plant and average motor energy.														
	3674	Microelectronics															

Easton calculated the motor energy per sector per state by using a national average motor energy use per employee at the 4 digit SIC level, multiplying that number by the regional employment to get a motor energy use per sector per state at the 4 digit SIC level. We then added all of the appropriate motor energies by 4 digit SIC to get the 2 digit SIC total motor energy use. We did not use a national average motor energy use per employee to find the 2 digit SIC motor energy because of significant regional differences in composition within the 2 digit SIC, with varying average motor uses per employee.

The two digit SIC estimates have been blacked out on this table because they are significantly less accurate than the method described above. The figures sent to NEEA in the preliminary report were based on these less accurate findings.

APPENDIX B

Number of Motors by Size and Sector

		Number of Motors								
		1 - 5 hp	**6 - 20 hp**	**21 - 50 hp**	**51 - 100 hp**	**101 - 200 hp**	**201 - 500 hp**	**501 - 1000 hp**	**1000+ hp**	**All Motor Sizes**
SIC	**Industry**									
20	Food and Kindred Products	40,959	14,068	3,859	1,494	1,120	560	249	-	62,247
24	Lumber and Wood Products	41,638	28,820	6,618	3,100	3,016	84	-	-	83,778
26	Paper and Allied Products	7,575	3,236	1,887	914	450	290	131	44	14,512
28	Chemicals and Allied Products	8,400	5,944	2,873	1,169	812	436	119	79	19,812
29	Petroleum and Coal Products	7,852	9,471	4,637	1,521	687	245	74	49	24,536
33	Primary Metals	7,396	3,510	1,439	471	282	229	94	40	13,447
1x	Mining	5,776	8,221	7,213	4,859	1,650	2,598	244	-	30,562
4971	Irrigation	2,689	4,970	17,890	32,916	-	-	-	-	58,465
4941	Water Supply and Wastewater	-	14	14	193	393	2,060	875	3,334	6,888

APPENDIX C

Motor Energy by Size of Motor and Sector

		Motor Energy (GWh)								
		1 - 5 hp	**6 - 20 hp**	**21 - 50 hp**	**51 - 100 hp**	**101 - 200 hp**	**201 - 500 hp**	**501 - 1000 hp**	**1000+ hp**	**All motor sizes**
SIC	**Industry**									
20	Food and Kindred Products	264	404	429	368	426	374	404	80	2,747
24	Lumber and Wood Products	166	481	444	593	891	287	0	0	2,865
26	Paper and Allied Products	192	454	887	1341	1281	1976	2077	1865	10,083
28	Chemicals and Allied Products	68	273	388	396	609	771	583	1171	4,259
29	Petroleum and Coal Products	15	87	184	181	206	238	163	406	1,481
33	Primary Metals	48	85	121	125	156	245	250	231	1,262
1x	Mining	44	258	455	685	508	1805	274	0	4,030
4971	Irrigation	289	534	1921	3535	0	0	0	0	6,278
4941	Water Supply and Wastewater	0	4	4	59	120	628	267	1016	2,100

APPENDIX D

Number of Motors by Application and Horsepower - for selected industries

Food					
Number of Motors by Application and Horsepower					
			Air		
Size Category	**Fans**	**Pumps**	**Compressors**	**Other**	**Total**
1 - 5 hp	4,530	6,153	1,100	40,544	52,327
6 - 20 hp	2,933	6,275	320	4,512	14,040
21 - 50 hp	433	1,088	667	1,642	3,830
51 - 100 hp	135	420	163	773	1,491
101 - 200 hp	18	170	77	868	1,133
201 - 500 hp			39	492	531
501 - 1000 hp				243	243
1000 + hp				28	28
All motor Sizes	8,049	14,106	2,366	49,102	73,623
Lumber					
Number of Motors by Application and Horsepower					
			Air		
Size Category	**Fans**	**Pumps**	**Compressors**	**Other**	**Total**
1 - 5 hp	2,356	779	312	38,182	41,629
6 - 20 hp	3,712	1,562	1,626	21,952	28,852
21 - 50 hp	890	672	774	4,294	6,630
51 - 100 hp	147	373	171	2,391	3,082
101 - 200 hp	295	13	353	2,335	2,996
201 - 500 hp				620	620
501 - 1000 hp					-
1000 + hp					-
All motor Sizes	7,400	3,399	3,236	69,774	83,809
Paper					
Number of Motors by Application and Horsepower					
			Air		
Size Category	**Fans**	**Pumps**	**Compressors**	**Other**	**Total**
1 - 5 hp	983	1,172	115	5,315	7,585
6 - 20 hp	570	825	140	1,701	3,236
21 - 50 hp	196	593	99	999	1,887
51 - 100 hp	83	321	84	434	922
101 - 200 hp	64	180	17	189	450
201 - 500 hp	12	119	8	151	290
501 - 1000 hp	25	36	10	55	126
1000 + hp	17	1		28	46
All motor Sizes	1,950	3,247	473	8,872	14,542

APPENDIX D (Continued)

Chemicals					
Number of Motors by Application and Horsepower					
			Air		
Size Category	**Fans**	**Pumps**	**Compressors**	**Other**	**Total**
1 - 5 hp	838	3,330	101	4,139	8,408
6 - 20 hp	473	3,159	179	2,128	5,939
21 - 50 hp	315	1,076	167	1,309	2,867
51 - 100 hp	201	335	137	495	1,168
101 - 200 hp	168	301	118	217	804
201 - 500 hp	53	148	55	181	437
501 - 1000 hp	12	5	19	91	127
1000 + hp		15	40	18	73
All motor Sizes	2,060	8,369	816	8,578	19,823
Petroleum					
Number of Motors by Application and Horsepower					
			Air		
Size Category	**Fans**	**Pumps**	**Compressors**	**Other**	**Total**
1 - 5 hp	1,535	2,671	144	3,485	7,835
6 - 20 hp	414	4,972	149	3,928	9,463
21 - 50 hp	361	1,674	406	2,199	4,640
51 - 100 hp	212	580	32	684	1,508
101 - 200 hp	85	440	8	161	694
201 - 500 hp	5	204	13	28	250
501 - 1000 hp	2	49	6	12	69
1000 + hp	3	29	18	5	55
All motor Sizes	2,617	10,619	776	10,502	24,514
Primary Metals					
Number of Motors by Application and Horsepower					
			Air		
Size Category	**Fans**	**Pumps**	**Compressors**	**Other**	**Total**
1 - 5 hp	902	1,024	248	5,202	7,376
6 - 20 hp	575	795	297	1,833	3,500
21 - 50 hp	299	402	109	620	1,430
51 - 100 hp	25	118	20	310	473
101 - 200 hp	56	50	26	151	283
201 - 500 hp	15	10	88	114	227
501 - 1000 hp	7		8	74	89
1000 + hp	12		14	7	33
All motor Sizes	1,891	2,399	810	8,311	13,411

Appendix E

List of NEEA Programs

NEEA Motor Energy Conservation Initiatives

- Drive Power Initiative
- Compressed Air Challenge
- SavAir: compressed air system efficiency venture
- ASDs in refrigerated warehouses (evaporator fan ASDs)
- Just Enough Air: fan speed reduction for pneumatic conveying systems
- BacGen Biowise: Wastewater treatment
- Scientific Irrigation Scheduling - ASD coupling venture
- Microelectronics (several programs)
- Membership in the Consortium for Energy Efficiency
- Premium Efficient Motors Program (ended)
- Motor testing program (ended)

Appendix F

Basis of Motor Energy Estimates

1. Description of Methodology Used for Major Manufacturing Industries

(Paper and Allied Products, Lumber and Wood Products, Food and Kindred Products, Chemicals and Allied Products, Petroleum and Coal Products, Primary Metals, Other)

1.1 Total Motor Energy Use

1.1.1 The Interim Report

The numbers used in the first progress report (interim report) were based on different estimates than those used for the final report. These estimates were based on 2-digit SIC industry categories. The 1994 manufacturing Energy Consumption Survey estimates were the basis. Energy use estimates for the Pacific Northwest were based on the Pacific Northwest employment in the industry as a portion of the national employment.

1.1.2 The Final Report

The numbers used in the final report are based on motor energy statistics from the 1994 Manufacturing Energy Consumption Survey. Easton took the national energy usage by 4 digit SIC and process use and formulated a national motor energy use by 4 digit SIC. We then took the employment by state and nationally by 4 digit SIC from the Annual Survey of Manufacturers. Using a ratio of state to national employment we arrived at an estimated motor energy use per state per 4 digit SIC. We then added the appropriate 4 digit SICs to arrive at motor energy use by state by 2 digit SIC. This method is more accurate than simply getting a employment ratio times the 2 digit SIC because of the significant differences in motor energy use per employee between different 4 digit SICs within the same 2 digit SIC category.

1.2 The Number of Motors Present

The total number of motors per industry (2 digit SIC) was determined by taking the total motor energy for the 2 digit SIC per state and dividing by average size and average hours of use of the motors (from the United States Industrial Motor Systems Market Opportunities Assessment, henceforth the "DOE Study").

1.3 Annual Sales of Motors

Easton calculated the annual sales of motors by adding the replacement rate of motors (based on the average life of motors) to the industry growth rate and multiplying that number by the total number of motors present in the industry.

1.4 Motor Energy by Application

Easton used the same ratios as the national numbers indicated in the DOE Study and scaled them to the PNW region based on total motor energy use.

1.5 Savings Potential

The savings potential for the 2 digit SICs was estimated using the DOE Study's numbers and scaling them to the region by using the differences in total motor energy use.

1.6 Profiles of Key Manufacturing Locations

Easton compiled these lists of manufacturing locations by 2 digit SIC by using the online database, Reference USA.

2. Description of Methodology Used for Irrigation

2.1 Total Motor Energy Use

Easton based its estimate of total motor energy use in the irrigation sector on data from several different sources including the Fourth Northwest Conservation and Electric Power Plan (Appendix G), 1994 Farm and Ranch Irrigation Survey, and the DOE Study. We used the acres of land irrigated and the average pump size and hours of use to estimate the total pump motor energy use.

2.2 Number of Motors Present

The number of motors present was based on the number of pumps used (based on land irrigated and energy/water use per acre).

2.3 Annual Sales of Motors

Same as 1.3.

2.4 Other Estimates

The motor energy by application, savings potential, and key manufacturing locations were all calculated in the same manner as for the major manufacturing locations.

3. Description of Methodology Used for Water Supply and Wastewater Treatment

3.1 Total Motor Energy Use

Easton based its motor energy use for water supply and wastewater treatment on motor energy used per gallon, gallons per person, and population. Water supply and wastewater treatment numbers were handled separately in their estimation and then added together for the final report.

3.2 Other Estimates

The number of motors, annual sales of motors, savings potential and list of manufacturing locations were all based on the same methodology used for the major manufacturing industries (1.2 – 1.6).

4. Description of Methodology Used for Mining

4.1 Total Motor Energy Use

Easton based its total motor energy use number for mining by combining the 2 numbers listed for SIC 10 (metal mining industries) and SIC 14 (nonmetal mineral mining industries) in the 1992 Census of Mineral Industries. To get the motor energy use per state we used an employment ratio as before.

4.2 Other Estimates

The number of motors, annual sales of motors, savings potential and list of manufacturing locations were all based on the same methodology used for the major manufacturing industries (1.2 – 1.6).

5. Description of Methodology Used for Microelectronics

Easton did not use the same methodology used for the rest of the manufacturing industries for microelectronics because microelectronics in the pacific northwest is growing so rapidly that the secondary sources available to make estimates would not have adequately described the current size of the microelectronics industry.

5.1 Total Motor Energy Use

Easton used information from three expert interviews to base its estimate of total energy demand hours of operation per plant. Total motor energy per state was then based on the number of plants, and average motor energy per plant.

5.2 Number of Motors and Annual Sales of Motors and Manufacturing Locations

Same methodology as 1.2 and 1.3 and 1.6, respectively.

5.3 Motor Energy by Application

This estimate was based on information from the expert interviews.

5.4 Savings Potential

The microelectronics savings potential categories estimates were based on the numbers given in the DOE Study for all electronics and modified by information from the expert interviews.

6. Description of Methodology Used for Appendices

6.1 Methodology for Appendix A

Easton calculated the motor energy per sector per state by using a national average motor energy use per employee at the 4 digit SIC level, multiplying that number by the regional employment to get a motor energy use per sector per state at the 4 digit SIC level. We then added all of the appropriate motor energies by 4 digit SIC to get the 2 digit SIC total motor energy use. We did not use a national average motor energy use per employee to find the 2 digit SIC motor energy because of significant regional differences in composition within the 2 digit SIC, with varying average motor uses per employee.

The two digit SIC estimates have been blacked out on this table because they are significantly less accurate than the method described above. The figures sent to NEEA in the preliminary report were based on these less accurate findings.

We did not use employment data to find the motor energy use in the PNW. For these sectors we used acres of land irrigated and gallons of water treated.

We did not use national employment data to find the motor energy use in the PNW for microelectronics. Instead, with information from industry experts we estimated using number of plants, employees per plant and average motor energy.

6.2 Methodology for Appendix B and D

Easton calculated the number of motors by horsepower and sector, and number of motors by application and horsepower by selected sector by comparing our modified regional total number of motors to the national number of motors given in the DOE Study. We applied this ratio to the tables supplied in the DOE study to get our regional Pacific Northwest number of motors by size and sector and number of motors by application and size for selected sectors.

6.3 Methodology for Appendix C

In a similar fashion, Easton compared the modified total regional energy numbers that we calculated in Appendix A to the total national motor energy numbers supplied by the DOE study. With this ratio we calculated the motor energy use per motor size category for each sector.

Appendix G

Targeting Standard vs. Special Motors

There is some controversy as to the importance in targeting standard motors in contrast to special purpose motors. While there is no public information as to the number of motors that fall into these two categories, a recent regional study that Easton conducted in the Northeast of the subject showed the following breakdown by size of motor:

Horsepower	Percent Standard (ODP and TEFC)	Percent Special Purpose
1 to 5	46%	54%
6 to 20	84%	16%
20 to 50	87%	13%
over 50	99%	1%
Average	58%	42%

Clearly the number of non-standard motors are sizeable, but they tend to be found in the smaller sizes where the energy consumption is less. Therefore the focus of a motor efficiency program on standard motors EPAct and the "Premium" (energy efficient) models is appropriate.