Technical, Economic, and Financial Assessment of Energy Efficiency Investment Options For the Jiangshan Agrichemical and Chemical Co.

Nantong Municipality
Jiangsu Province
People's Republic of China

Final Report

Prepared For

Jiangsu Economic and Trade Commission

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Contents

1 Summary

1.1 INTRODUCTION

This report details the recommendations and conclusions of an energy study co-sponsored by Jiangsu Economic and Trade Commission, Natural Resources Defense Council (NRDC), the Nantong Municipal Committee of Economy and Trade, the State Grid Corporation DSM Instruction Center and the Jiangshan Agrichemical and Chemical Company (JA&C).[1]

This study targeted energy efficiency measures (EEMs) addressing motors, drives, compressed air, pumps, and transformers. Section 2 contains a facility energy usage profile and a statistical analysis of energy use and production. Section 3 discusses each recommended measure in detail. A summary of recommended energy efficiency measures is shown in Table 1-3.

Section 4 provides information on best practices regarding energy-efficiency opportunities at the plant. Section 5 presents the economic and financial analysis of all the EEMs studied, and the financial incentives we recommend that the Economic and Trade Commission consider offering JA&C for various combinations of EEMs the plant might choose. Section 6 outlines our recommended approach for monitoring and verifying installation and performance of the recommended EEMs

1.2 CURRENT ENERGY USE

The total annual consumption of the Jiangshan Agrichemical and Chemical Co. for 2005 (the new facility is now being brought on line and is not included) was 360,240,000 kWh with a peak monthly energy use of 31,888,550 kWh in October. Table 1-1 presents the monthly electrical energy use.

[1] Stephen Booth of SGB PC (SGB) conducted the technical study of energy-efficiency measures. Booth also developed the monitoring and verification (M&V) approach for the motor efficiency measures in Appendix 7.2-7.5. John Plunkett and Francis Wyatt of Green Energy Economics Group conducted the economic analysis of energy-efficiency measure costs and performance developed in the technical study, and the financial analysis and incentive design. We gratefully acknowledge the information and advice provided by Timothy Hui of Natural Resources Defense Council (NRDC), the DSM Center staff, and the management and staff of JA&C.

Table 1-1
Electric Billing History

Month	Total Energy MWh	Internally Generated MWh	Grid Supplied MWh
Jan	30,139	11,859	18,279
Feb	26,236	11,984	14,252
Mar	31,092	11,980	19,112
Apr	30,446	11,094	19,352
May	31,276	11,928	19,348
Jun	31,056	11,957	19,098
Jul	31,354	12,632	18,723
Aug	31,788	12,157	19,631
Sep	31,297	11,389	19,908
Oct	31,889	11,682	20,207
Nov	22,526	6,721	15,805
Dec	31,151	12,963	18,189
Total	360,249	138,344	221,905

Table 1-2 presents JA&C's electric billing structure.[2]

Table 1-2
Electricity Rate Structure

Voltage	Billing Period	Energy Cost (¥/KVA)	Demand Cost (¥/KVA)
35 KV	Peak Shoulder Off-Peak	0.862 0.517 0.232	23
110 KV	Peak Shoulder Off-Peak	0.857 0.514 0.231	23

The electric demand load profile is approximately flat at a load of 33,000 KW from 12 am to 8 am for purchased power. At 8 am the site power plants increase

[2] The electricity billing periods are as follows. Peak billing period is from 8 am to 12pm, and from 5 pm to 9 pm. The shoulder period is from 12 pm to 5 pm, and from 9 pm to 12 am. The off-peak period is from 12 am to 8 am. The average electricity price is 0.52 RMB per kWh.

production to reduce the load to an average of 21,000 KW during the peak and shoulder hours of the day to reduce cost.

The company now owns 34 transformers of all kinds, reaching a total power capacity of 99,350 kVA, among which there are 2 main transformers of 16,300 kVA， 4 rectifier transformers of 28,000 kVA, 2 degradation transformers of 2700kVA, and 26 distribution transformers of 52,350 kVA.

1.3 Recommended Energy Efficiency Measures (EEMs)

We recommend seven (7) EEMs for implementation at the Jiangshan Agrichemical and Chemical Co. Table 1-3 describes the EEMs recommended and subjected to financial analysis.

Table 1-3
Summary of Recommended Energy Efficiency Measures

	Measure	Construction Cost (rmb)	Demand Savings (KW)	Energy Savings (KWh)	Energy Cost Savings (rmb)	Simple Payback (years)
EEM-1	High-E Motors	2,463,923	211.0	1,677,845	872,479	2.8
EEM-2	Variable Speed Drives	3,604,500	591.2	4,564,534	2,373,557	1.5
EEM-3	Synchronous Belts	1,055,714	150.0	1,083,540	563,440	1.9
EEM-4	Downsize Motors	680,841	124.4	848,125	441,026	1.5
EEM-5	Replace Transformers	1,280,500	70.3	616,080	320,360	4.0
EEM-6	Repair CA Leaks	40,000	23.6	169,920	88,354	0.5
EEM-7	Optimize Compressors	150,000	51.1	408,800	212,600	0.7
	Total	9,275,477	1,222	9,368,844	4,871,816	1.9

1.4 Economic and Financial Analysis Results

All the recommended EEMs were found to provide cost-effective efficiency power plant (EPP) resources to the Jiangsu electricity grid. Jiangsu would benefit most if JA&C installed all recommended EEMs. Net economic benefits over the life expectancies of all recommended measures are estimated at ￥25,625,981 in 2007 present worth, on total economic costs of ￥6,389,242.

Any EEM or combination of EEMs with simple payback periods longer than one year require JA&C to raise capital, by some mix of additional borrowing and equity investment. If JETC can provide financial incentives to bring the simple payback measures of all EEMs together down to one year, JA&C can finance the investment out of operating cost savings. To make this economically superior outcome the most financially attractive choice, we recommend that JETC be prepared to offer JA&C up to ￥3,398,263, or 42% of the total (undiscounted) costs of all EEMs together of ￥8,091,104. JA&C's share of the investment would be ￥4,692,840, from which it would earn a 103% annual rate of return.

Savings from some of the recommended EEMs could probably qualify for sale as Certified Emission Reductions (CERs) under the UN's Clean Development Mechanism. Proceeds from the sale of CERs could cover half the cost of all the recommended EEMs combined, or 84% of the contribution needed by JA&C.

2 Energy Use Profile

2.1 Facility Description

Jiangshan Agrichemical and Chemical Co. Ltd. is a comprehensive company specializing in the production of pesticide, PVC resin, chlorine, sodium hydroxide, and other refined chemical products. It is a listed company in Shanghai Stock Exchange. By the end of 2005, it had total assets of 1.54 billion ¥, with its premises covering 330,000 m2. In 2005 the annual sales of the company totaled 1.8 billion ¥, and the annual profits were 76,110,000 ¥.

The product line is classified into five categories and over seventy different types of chemicals including pesticide, PVC resin, chlorine and sodium hydroxide, other refined chemical products, and thermoelectricity. The primary products are: sodium hydroxide, glyphosate, ddvp, dipterex, PVC, chloromethane, and acetohlor. The intermediate products are: dimethylester, chloral, chlorine hydride, chloroethylene and phosphorous dichloride. The production and sale total of pesticides was ranked first in China for the last three years. The production capacity of dipterex, monocrotophos, acettochlor and glyphosate rank the top three. PVC production at 140,000 tons per year; 100％ sodium hydroxide at 90,000 tons per year; refined chemical and basic products 219,100 tons per year; and trim ethyl phosphate 12,000 tons per year; rank as the highest production capacity in Asia.

The total energy consumption of the company in 2005 is about 232,400 tons of coal equivalent, bunker coal accounting for 224,100 tons. The power capacity of the old company area is 45,900 kVA and the new area 25,000 kVA. The company possesses two industrial power plants, the old company area is equipped with five boilers and four generators; the new company area is equipped with two boilers and one generator.

2.2 ENERGY USE PROFILE

The facility's electrical energy use is billed at ¥0.857 per kWh peak, ¥0.231 per KWh off-peak, and 23¥/KVA per month. The facility reports that the average electricity cost is ¥0.52/KWh. Due to the high cost of peak electricity the plant produces much of their own power during peak hours with the two on-site, coal-fired power plants. Table 2-1, below, summarizes electrical energy use at the Jiangshan Agrichemical and Chemical Co. by principal products.

Table 2-1
Annual Energy Consumption by Product Type

Product	Annual Production (tons/year)	Energy Consumption (KWh/ton)	Annual Energy Consumption (KWh/year)	Percent of Total
Sodium Hydroxide	92,000	2,561	235,612,000	65.4%
Glyphosphate	10,741	1,229	13,200,689	3.7%
Dimethylester	11,949	601	7,181,349	2.0%
Phosphorus Trichoride	14,884	40	595,360	0.2%
DDVP	10,181	241	2,453,621	0.7%
Chloral	10,345	69	713,805	0.2%
Dipterex	4,775	196	935,900	0.3%
PVC	118,000	213	25,134,000	7.0%
Chloroethylene	66,900	316	21,140,400	5.9%
Chlorine Hydride	44,094	57	2,513,358	0.7%
Chloromethane	11,626	170	1,976,420	0.5%
Acettochlor	3,836	557	2,136,652	0.6%
Other Products (58 types)			46,646,446	12.9%
			360,240,000	100.0%

It is readily apparent that the production of Sodium Hydroxide is both one of the company's largest products, and by far the largest consumer of electricity in production. The majority of the energy is used in the electrolysis process.

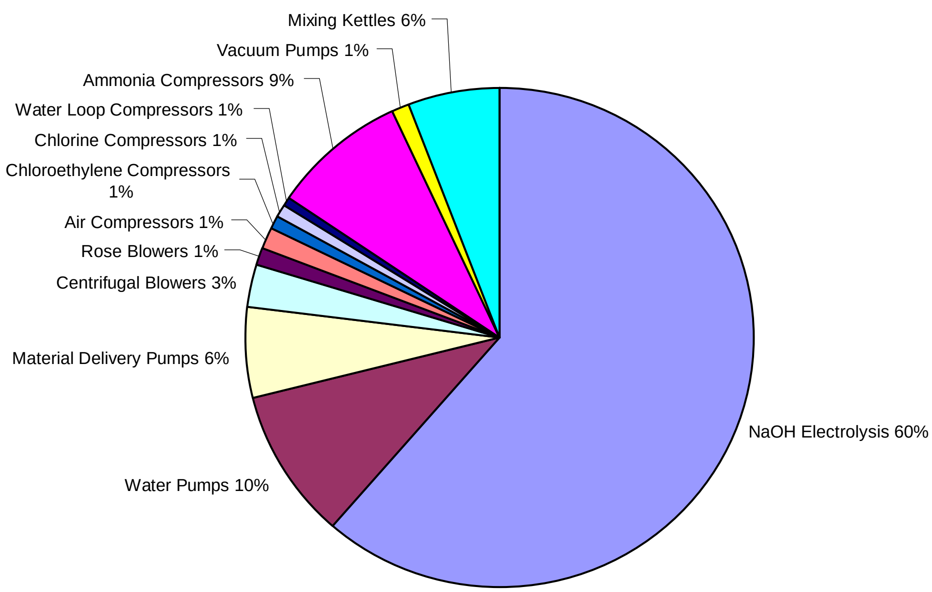
2.3 END-USE ELECTRICAL EQUIPMENT

Company personnel provided us with a list of the equipment and processes used in the facility. An electrical energy end-use breakdown is presented in Table 2.1 and represented graphically in Figure 1-1. Of the end uses the anode electrolysis process used in the production of sodium hydroxide represent the largest electrical energy end use, followed by: water pumping, material delivery, and material mixing. There is less then 1% of energy consumption attributed to lighting and limited air-conditioning that equates to a very small percentage of the overall load.

Table 2-2
Electrical Energy Use Breakdown by Equipment

Equipment Type	Demand (kW)	Electric Consumption (kWh/yr)	Percent by Equipment Type
NaOH Electrolysis	26,896	221,187,360	61%
Water Pumps	10,219	34,789,551	10%
Material Delivery Pumps	6,295	21,430,690	6%
Centrifugal Blowers	2,982	10,151,917	3%
Rose Blowers	1,103	3,755,052	1%
Air Compressors	1,478	5,031,701	1%
Chloroethylene Compressors	911	3,101,407	1%
Chlorine Compressors	832	2,832,460	1%
Water Loop Compressors	685	2,332,013	1%
Ammonia Compressors	9,062	30,850,662	9%
Vacuum Pumps	1,026	3,492,913	1%
Mixing Kettles	6,252	21,284,301	6%
	67,741	360,240,029	100%

Figure 2.1



Company personnel provided us with the motor inventory, with operating hours and motor load. The information provided is presented in Appendix 7.1 (Motor Powered Equipment). We calculated the annual electrical energy use in Appendix 7.1 to be 79,139,500 kWh

3 Energy Efficiency Measures

This section provides details of recommended Energy Efficiency Measures (EEMs) for Jiangshan Agrichemical and Chemical Co. located in Nantong. Eight (7) EEMs have been studied and are recommended for implementation. They are listed below.

- EEM-1 Replace Y-Series and JO2-Series Motors with YX-Series Motors
- EEM-2 Install Variable Frequency Drives (VFD's) on systems with variable loads or on systems that are throttled.
- EEM-3 Replace standard V-Belts with Synchronous Belts on all belt driven systems.
- EEM-4 Replace motors that are operating at 50% or less of design load with correctly sized premium efficient motors
- EEM-5 Consider installing S11 transformers when replacing existing transformers.
- EEM-6 Repair compressed air leaks and maintain air distribution system.
- EEM-7 Replace fully loaded reciprocating compressors with rotary-screw or centrifugal compressors. Use reciprocating or VFD controlled compressors for trim applications.

These EEMs should be reviewed to determine if they are consistent with the actual operational requirements of Jiangshan Agrichemical and Chemical Co. and the desires of facility management. The following sections present estimated implementation costs as well as energy and cost savings for each measure.

3.1 EEM-1 Replace JO2-Series and Y-Series Motors with YX-Series Motors

Description:	The plant is equipped primarily with Y series standard efficiency motors and 21 lower-efficiency JO2-series motors. Premium YX-series motors have efficiencies of approximately 1% to 3% than their standard-efficiency counterparts. Purchasing YX-series motors would save much energy and cost over motors' lifetime.		
Action:	Replace Y series and JO2-series motors with YX-series motors.		
Recommendation:	This EEM is cost effective and is recommended for implementation.		
ENERGY IMPACTS			
Total Cost (¥)	**Annual Energy Savings (kWh)**	**Annual Savings (¥)**	
2,070,000	**1,677,850**	**872,500**	
		Simple Payback (years):	**2.4**

3.1.1. Discussion

Company personnel provided us with a list of all large motors used in the process. Most motors are standard-efficiency Y-series motors, and 21 are even lower-efficiency JO2-series motors. Premium-efficiency YX-series motors are commercially available, and are between 1% and 3% more efficient than standard-efficiency motors. Although they cost between 30% and 50% more to purchase than standard-efficiency motors, YX-series motors have significantly lower life-cycle costs.

Appendix 7.2 (Potential Motor Requirements) shows the motor replacement analysis. Y-series motors cost between ¥100 and ¥120 per rated kW, and YX-series motors cost up to 50% more. Thus, we used a cost of ¥170 per kW equipment cost plus ¥25 per kW for installation in Appendix 7.2.

3.1.2. Recommendation

We recommend replacing Y-series and JO2-series motors with YX-series motors. The economics are favorable for the motors to be replaced immediately due to the long run-time per year.

3.1.3. Energy Savings, Cost Savings, and Implementation Cost

Table 3.2 is a list of motor efficiencies taken directly from the publication “The Chinese Market for Electric Motors and Motor Speed Controls” (Hinge, Nadel, Yande, Lan, Chunxuan. ACEEE. 1997). These efficiencies are identical to those reported in the more recent publication “The China Motor Systems Energy

Conservation Program: A Major National Initiative to Reduce Motor System Energy Use in China" (Nadel, Wanxing, Liu, McKane. DOE Office of Scientific & Technical Information. 2001).

Table 3-2
Motor Efficiencies

Rated	Output		Chinese Motor Series			
			(IEC Test Proc.)			
(kW)	(HP)	JO2	Y(IP44)	YX	Y2	Y2E
0.55	0.75	74.0	73		71.0	73.5
0.75	1.0	76.5	74.5		73.0	75.5
1.1	1.5	79.0	78.0		75.0	76.5
1.5	2.0	80.5	79.0		78.0	79.5
2.2	3.0	82.0	81.0	86.3	80.0	82.0
4.0	5.0	85.0	84.5	88.3	84.0	86.0
5.5	7.5	86.0	85.5	89.5	85.0	87.0
7.5	10	87.0	87.0	90.3	87.0	88.0
15	20	88.0	88.5	91.8	89.0	91.0
18.5	25	89.0	91.0	93.0	90.7	92.7
22	30	89.5	91.5	93.2	91.2	93.0
30	40	90.0	92.2	93.5	92.0	93.5
45	60	91.0	92.3	94.1	93.0	94.2
55	75	91.5	92.6	94.5	93.2	94.5
75	100	92.0	92.7	94.7	93.8	94.7
90	125	92.0	93.5	95.0	94.2	95.0
110	150		93.5		94.5	
132	175		94.0		94.8	

Note: efficiencies are shown for totally-enclosed fan-cooled 4-pole motors

Source: Hinge, Nadel, Yande, Lan, Chunxuan. "The Chinese Market for Electric Motors and Motor Speed Controls." American Council for an Energy-Efficient Economy 1997: p. 24.

3.2 EEM-2 Install Variable Frequency Drives (VFDs)

Description:	Many of the systems in the facility have variable loads such as the fans on a cooling tower that vary with the seasons, or are throttled to adjust for variations in production output. By installing VFD's on motors with centrifugal loads cubic energy savings will result.
Action:	Install variable frequency drives on motors with variable loads. Control either manually, by pressure, or by temperature in accordance with the requirements of the process.
Recommendation:	This EEM is cost effective and is recommended for implementation.

ENERGY IMPACTS

Total Cost (¥)	Annual Energy Savings (kWh)	Annual Cost Savings (¥)		
3,604,500	**4,542,725**	**2,362,220**	**Simple Payback (years):**	**1.5**

3.2.1. Discussion

The fan/ pump affinity laws show that the load on a motor in kW varies as the cubic function of the motor revolutions per minute. By slowing the motor down when the process is not fully load significant savings will result. Appendix 7.3 (Variable Frequency Drive Measures) shows the cost and savings associated with the installation of VFD's on selected motors.

3.2.2. Recommendation

The installation of variable frequency drives is recommended due to the large cost savings associated with the measure, the increased motor life, and the flexibility the drives provide to the operator to carefully match the motor power to the load.

3.2.3. Energy and Cost Savings

The installation of Variable frequency drives could affect 85 motors with a total connected rating of 9,760 kW. By inputting values into the following equation it can be shown that slowing the motor revolutions down by 50% yields a reduction in motor demand by 87%.

Future Demand KW2 = Existing KW x (RPM2/RPM1)^3

Where RPM is the Revolutions per minute of the motor.

3.2.4. Implementation Cost

The implementation of variable frequency drives involves both an electrical installation component and a controls component. The electrical installation component requires the installation of the drive between the power source and the driven load. The controls component requires a signal from the process whether it is manual from the operator or, from temperature or pressure sensor that will be processed by the drive controls to modify the motor speed. The drive cost has been estimated at 850 ¥ per kW of load plus an additional 150 ¥ per kW for installation and controls for a total of 1,000 ¥ per kW.

3.3 EEM-3 Replace Standard V-Belts with Synchronous Belts

Description:	A number of compressors, vacuum pumps, condensers, fans, etc. are belt driven to transmit power and to change the drive revolutions per minute. Each of these loads is driven with standard V-belt drives. Standard V-belts of this type have an efficiency of about 92% which indicates that about 8% of the work produced by the motor is lost as heat as the belts flex and slip as they go around the pulleys. Synchronous-belts are available and have an efficiency of transmission of 98%.
Action:	Replace standard V-belts with synchronous belts.
Recommendation:	This EEM is cost effective and is recommended for implementation.

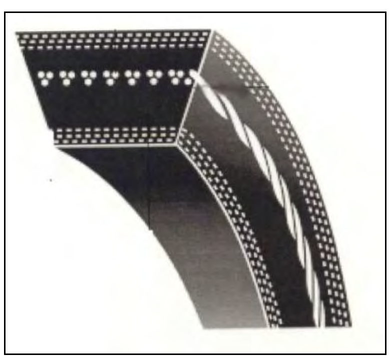
ENERGY IMPACTS

Total Cost (¥)	Annual Energy Savings (kWh)	Annual Cost Savings (¥)		
1,055,700	1,083,540	563,440		
			Simple Payback (years):	**1.9**

3.3.1. Discussion

The belt driven loads on site have motors equipped with standard V-belts with smooth inner surfaces. Figure 3-1 shows a cross-section of a standard V-belt. The smooth inner surface permits a significant amount of slip between the belts and the sheaves. The slip is exaggerated when multiple belts of slightly different lengths and wear patterns serve the same load. By installing Synchronous or toothed belts with corresponding toothed sprockets slip is virtually eliminated.

Figure 3-1
Standard V-Belt



Belt drives in motor driven applications allow flexibility in positioning the motor, and allow process rotating speed to be set based on pulley diameters. Wellmaintained standard V-belts have been shown to have an efficiency of approximately 93%, meaning that about 7% of the work produced by the motor is lost as heat as the belts flex and slip going around the pulleys. Over time the efficiency of v-belts deteriorates due to uneven wear and incorrect tensioning. Synchronous belts provide a positive transmission of power similar to a chain drive but require no lubrication, resist corrosion, are un-affected by abrasive particles, can operate in wet conditions, and do not experience break-down in efficiency over time.

According to the Department of Energy's (DOE) Industrial Technologies Program (ITP), synchronous belts increase the efficiency of transmission by approximately 6%. In addition to significantly improving power-transmission efficiency, synchronous belts also last at least four times longer than standard V-belts. This considerably reduces the equipment downtime and replacement costs. However, synchronous belts are more costly than comparable standard V-belts. Table 3-4 summarizes the characteristics of different belt types.

Table 3-4
Drive Belt Characteristics Comparison

Comparison of Belt Drive Characteristics

	Typical Efficiency Range (%)	Suitable for Shock Loads	Periodic Maintenance Required	Change of Pulleys Required	Special Features
V-Belts	90–98	Yes	Yes	No	Low initial cost.
Cogged V-Belts	95–98	Yes	Yes	No	Easy to retrofit. Reduced slip.
Flat Belts	97–99	Yes	No	Yes, but low cost	Medium- to high-speed applications. Low noise. Low slip.
Synchronous Belts	97–99	No	No	Yes, with higher cost	Low- to medium-speed applications. No slip. Noisy. May have problems matching speed.

Source: de Almeida and Greenberg 1994

3.3.2. RECOMMENDATION

Because of the advantages, the use of synchronous belts is recommend in virtually all V-belt applications except for those that experience shock loading.

3.3.3. ENERGY AND COST SAVINGS

The following calculations are based on actual motor loads provided by the system operators. Appendix 7.4 (Energy Savings Analysis for V-Belt Driven Motors) shows the results of demand and energy savings from replacing standard V-belts with synchronous belts. The results assume that standard V-belts are 92% efficient, and alternate synchronous belts are 98% efficient.

Two calculations incorporated into Appendix 7.4 are as follows:

Existing Demand = Qty x Actual Power Rating

Demand Savings = Existing Demand x [1 – (Std V-Belt Eff / Synchronous Belt Eff)]

3.3.4. IMPLEMENTATION COST

We measured the belt size and sheave size of a number of belt driven systems throughout the facility and developed cost estimates to replace the sheaves and v-belts with synchronous sprockets and belts. The average cost of the retrofits was 518 ¥ per kW of motor load.

3.4 EEM-4 REPLACE OVERSIZED MOTORS

Description:	Many of the facility's motors are running at less then 50% of rated load. Motors are designed to achieve peak efficiency when 75% loaded. At less then 50% load the motor efficiency begins to drop, and at 25% load the efficiency can be reduced 10% or more from the peak. By replacing the over-sized, Y-series motors on site with correctly sized, YX efficient motors the plant will see a significant reduction in energy cost per unit of production.
Action:	Replace Y series and JO2-series motors with correctly sized YX-series motors.
Recommendation:	This EEM is cost effective and is recommended for implementation.

ENERGY IMPACTS

Total Cost (¥)	Annual Energy Savings (kWh)	Annual Savings (¥)		
525,100	838,290	435,900		
			Simple Payback (years):	**1.2**

3.4.1. DISCUSSION

Company personnel provided us with a list of all large motors used in the process along with the loaded amperage of the motors. We were able to calculate the actual motor load based on this information. Appendix 7.5 (Oversized Motor Replacements) lists the motors that were significantly oversized for the loads served. Most of these motors are standard-efficiency Y-series motors. Premium-efficiency YX-series motors are commercially available at the required sizes and will have a significantly lower life-cycle cost.

3.4.2. RECOMMENDATION

We recommend replacing Y-series motors that are more then 50% over-sized with YX-series motors. The economics are favorable for the motors to be replaced immediately due to the long run-time per year.

3.4.3. ENERGY SAVINGS, COST SAVINGS, AND IMPLEMENTATION COST

Table 3.2 is a list of motor efficiencies taken directly from the publication “The Chinese Market for Electric Motors and Motor Speed Controls” (Hinge, Nadel, Yande, Lan, Chunxuan. ACEEE. 1997). These efficiencies are identical to those reported in the more recent publication “The China Motor Systems Energy Conservation Program: A Major National Initiative to Reduce Motor System Energy Use in China” (Nadel, Wanxing, Liu, McKane. DOE Office of Scientific & Technical Information. 2001). The United States Department of Energy (DOE) Motor Challenge Fact Sheet Motor Loading, Attachment C tabulates the effect of motor loading on motor efficiency. Y-series motors cost between ¥100 and ¥120 per rated kW, and YX-series motors cost up to 50% more. Thus, we used a cost of ¥170 per kW for replacement motor cost plus ¥25 per kW for installation.

3.5 EEM-5 REPLACE S7 TRANSFORMERS WITH S11 TRANSFORMERS

Description: Nantong Jiangshan is operating 9 S7 transformers that have to be phased out . Two options exist for transformer replacement: standard-efficiency S9 transformers, or premium-efficiency S11 transformers. Although S11 transformers are more expensive to purchase, their increased efficiency gives them a lower life-cycle cost.

Action: Consider installing S11 transformers to replacing S7 transformers.

ENERGY IMPACTS

Incremental Cost (¥)	Annual Energy Savings (kWh)	Annual Savings (¥)		
295,500	352,047	183,064		
			Simple Payback (years):	**1.6**

3.5.1. DISCUSSION

Nantong Jiangshan has nine S7 transformers that have to be phased out according Chinese relevant regulations. Table 3.7 shows these transformers.

Table 3-7
Transformers under Consideration for Replacement

No.	Dept.	Description	Model	Capacity or Rating(kVA)
1	G	1600 directly distributed transformer	S7—1600	1600
2	G	Northern 1250 transformer	SL7—1250/10	1250
3	G	750kVA transformer in southern substation	SL7—750/10	750
4	G	Duel-freezing 1250 transformer	SL7—1250/10	1250
5	G	Transformer of waste treatment	S7—1000/10	1000
6	G	Transformer 1# of plant	S7—1000/10	1000
7	G	Transformer 2# of plant	S7—1000/10	1000
8	G	Transformer 3# of plant	S7—1000/10	1000
9	G	Transformer 6# of plant	S7—1000/10	1000
Total				**9850**

G: Power station Transformers

Table 3-8
Transformer Analysis

	Number of Transformers	Total Capacity (MVA) for replacement	Power saving potential (KW)	Unit increment cost (¥/kVA)	Increment Investment if replaced by S9 & S11 (¥)	Annual electricity saving per increment (KWh)	Annual saving /a (replaced by S11, ¥)	Simple Payback (years)
S7	9	9.850	0	0	0	0	0	0.00
S9 Replacement		9.850	30.14	100	985,000	264,035	137,298	7.17
S11 Replacement		9.850	40.19	30	295,500	352,047	183,064	1.61
total		9.850	70.33	130	1,280,500	616,082	320,363	4.00

Two major types of transformers are commercially available: standard-efficiency S9 transformers and high-efficiency S11 transformers. This study used costs and savings for replacing existing transformers with S11 transformers. S11 transformers may become standard practice in the next few years.

3.5.2. Recommendation

We recommend considering S11 transformers to replace existing S7 transformers immediately. According to the following analysis, the payback to recoup the additional (or incremental) cost of purchasing S11 transformers rather than S9 transformers would be 1.6 years.

3.5.3. Energy Savings, Cost Savings, and Implementation Cost

It was assumed that the transformers are 60% loaded, and the power factor is 85%. The average efficiency improvement is 0.6 % to go from S7 to S9 transformers. The average efficiency improvement is 0.8% to go from S9 to S11 transformers. The anticipated life of the S9 or S11 transformers is 20 years. It is assumed that the S7 transformers are at the end of their life. The total cost to install S9 transformers is 100 ¥/KVA. The cost to install S11 transformers is 130¥ /KVA.

3.6 EEM-6 Repair Compressed Air Leaks and Maintain Air Distribution System

Description:	Compressed air leaks often contribute to a large portion of demand in a compressed air system. Most industrial plants have a compressed air leak load between 20% and 75%. Instrumentation and process consume large amounts of compressed air at many individual locations and these locations are susceptible to leakage. Repairing leaks is a cost-effective way to save energy in a compressed air system.			
Action:	Repair compressed air leaks, and maintain compressed air distribution system on at least a semi-annual basis.			
Recommendation:	This EEM is cost effective and is recommended for implementation.			
ENERGY IMPACTS				
Total Cost (¥)	**Annual Energy Savings (kWh)**	**Annual Savings (¥)**		
40,000	**169,920**	**88,358**		
			Simple Payback (years):	**0.5**

3.6.1. Discussion

Compressed air leaks in an air distribution system increase compressed demand and compressor power consumption. Repairing leaks and maintaining a compressed air distribution system is a cost-effective way to avoid excess compressor power consumption.

Nantong Jiangshan is equipped with eight air compressors to supply compressed air primarily for instrumentation and production. We did not perform a leak inspection. However, from past consulting experience, air leaks account for between 20% and 75% of air demand in a plant with no regular maintenance policy.

Compressed air leaks most commonly exist at threaded connection points, rubber hose connections, valves, regulators, seals, and old pneumatic equipment. Air leaks in industry typically average about 0.085 m3/min.

3.6.2. Recommendation

We recommend finding all compressed air leaks and repairing the leaks. This may involve tightening fittings, replacing thread-sealing tape, patching hoses, replacing seals, or replacing leaky equipment. In addition, we recommend maintaining the compressed air distribution system by performing an inspection and repair of compressed air leaks on at least a semi-annual basis.

3.6.3. ENERGY AND COST SAVINGS

Nantong Jiangshan is equipped with eight air compressors; 4 reciprocating ones with a capacity of 21.5 m3/min each , and 3 Ingersol Rand screw type ones with a capacity of approximately 19 m3/min each and one with a capacity of approximately 27 m3/min. Thus, the plant's total compressed air capacity is 170 m3/min.

Table 3-9
List of Plant Air Compressors

Type	# of Units	Rating (KW/Unit)	Total (KW)	Discharge (m^3/min-unit)	Total Discharge (m^3/min)
Reciprocating	4	130	520	21.5	86.0
Ingersol Rand Screw	3	110	330	19.0	57.0
Ingersol Rand Screw	1	150	150	27.0	27.0
Total	**8**		**1,000**	**67.5**	**170.0**

Although we were not able to monitor the compressors for an extended period of time, we assume that the average output of the compressed air system is half of its maximum capacity, or 85 m3/min.

As stated earlier, air leaks account for between 20% and 75% of air demand in a plant with no regular maintenance policy. Assuming air leaks may account for 10% of the air demand in Nantong Jiangshan, the air lost to leaks may be approximately 8.5 m3/min. Because a typical compressed air leak consumes approximately 0.085 m3/min, about 100 leaks would account for 8.5 m3/min.

The compressors operate in a load/unload fashion. "Load/unload" control is explained in detail in EEM-7. Because the Ingersol Rand compressors are the primary compressors, we assume that energy savings would be achieved from the Ingersol Rand compressors loading less often after leaks are fixed. Three Ingersol Rand compressors are rated at 110 kW power and 19 m3/min capacity each. One Ingersol Rand compressor is rated at 150 kW power and 27 m3/min capacity. EEM-7 also explains that rotary-screw compressors typically draw around 50% of full-load power when unloaded. Thus, the power saved from eliminating 8.5 m3/min would be approximately:

8.5 m3/min x (150 kW / 27 m3/min) x (100% - 50%) = 23.6 kW

Company personnel informed us that the compressors operate from 7,200 to 8,000 hours a year. Thus, annual electrical energy saved would be approximately 169,920 kWh. At a rate of ¥0.52 per kWh, the annual cost savings would be approximately ¥88,354.

3.6.4. Implementation Cost

The cost of repairing a compressed air leak, including parts and labor, is typically ¥400. The cost of repairing 100 leaks would be approximately ¥40,000.

3.7 EEM-7 Install Automatic Sequencer on Compressed Air System, Operate Reciprocating Compressor as Full-Time Trim, and set Proper Compressor's Operating Pressure

Description:	Nantong Jiangshan is equipped with four rotary screw air compressors and four reciprocating compressors. The compressors are staged such that three rotary screw compressors are the primary compressors to supply instrumentation air (air demand: 32 m3/min at pressure of 5 to 5.5 kg/cm2), and one rotary screw compressors plus one or two reciprocating compressor to supply process air (air demand: 47 m3/min at pressure of 2.5 to 3.2 kg/cm2). Because reciprocating compressors have significantly better part-load efficiencies than rotary screw compressors, it is advisable to operate the reciprocating compressor as the full-time trim compressor, and operate the rotary screw compressors fully-loaded. This can be done by the use of an automatic sequencer, which can control an entire compressed air system based on pressure in the compressed air header.
Action:	Install an automatic sequencer on the compressed air system, and operate the reciprocating compressor as full-time trim. Set proper compressor's operating pressure
Recommendation:	This EEM is cost effective and is recommended for implementation.

ENERGY IMPACTS

Total Cost (¥)	Annual Energy Savings (kWh)	Annual Savings (¥)	
150,000	**408,800**	**212,600**	
			Simple Payback (years): 0.71

3.7.1. Discussion

Nantong Jiangshan is equipped with eight air compressors to supply compressed air primarily for instrumentation and process, 4 reciprocating units with a capacity of 21.5 m3/min(130kW) each , 3 Ingersol Rand screw type units with a capacity of approximately 19 m3/min(110kW) each, and one unit with a capacity of approximately 27 m3/min(150kW). Thus, the plant's total compressed air capacity is 170 m3/min.

For process air, one 110-kW Ingersol Rand rotary screw compressor is used with an output capacity of 19 m3/min. The two of the four other compressors are older reciprocating units driven by 130-kW motors.

The compressors are staged to sequentially turn on and ramp up as compressed air demand increases. The order in which compressors turn on is: the rotary screw air compressor first, and the reciprocating compressors second. The rotary screw compressors operate during both high and low demand periods, and the reciprocating compressors are activated only when demand becomes high. Table 3.10 demonstrates the compressor staging arrangement, based on compressed air demand.

Table 3-10
Current Air Compressor Staging Arrangement

Compressed air demand	Rotary screw compressor operation	No 1 Reciprocating compressor	No 2 Reciprocating compressor
Demand <21.5 m^3/min	Part-loaded	Part-load	off
21.5m^3/min<demand<40.5m^3/min	Part-loaded	Part -loaded	Part-loaded
40.5m^3/min<demand<62m^3/min	Part-loaded	Part -loaded	Part-loaded

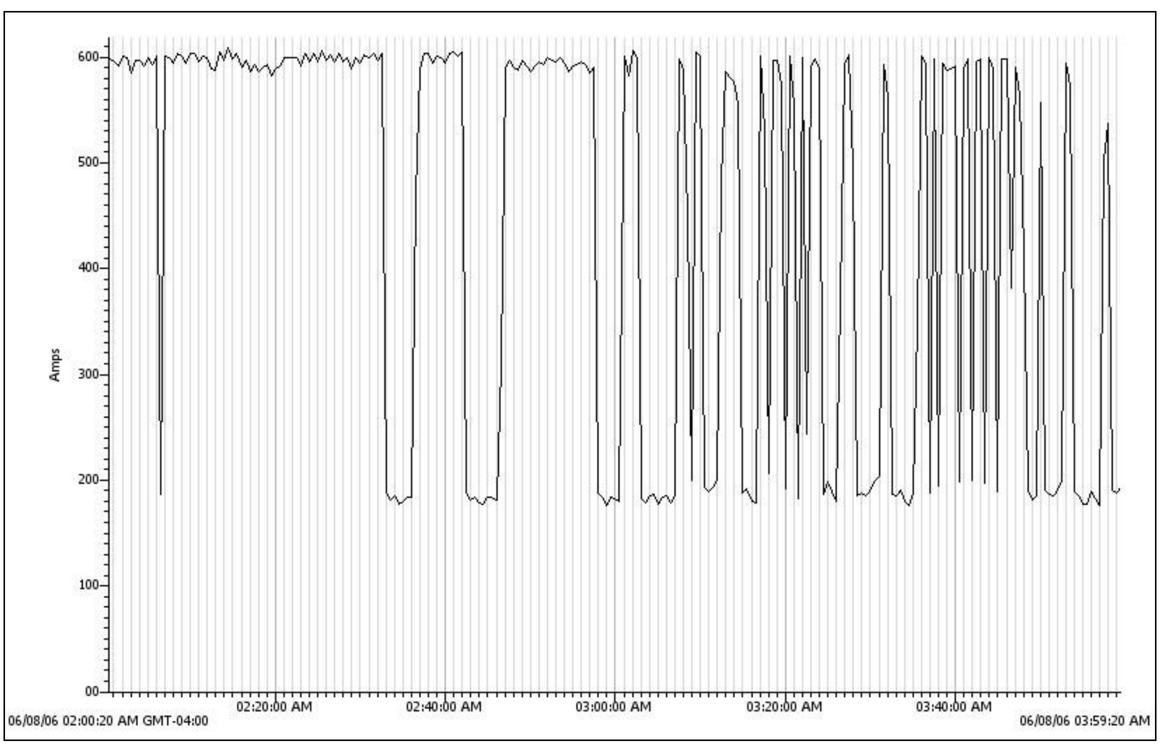
When partially-loaded, the rotary-screw compressors operate in “load/unload” control, in which the inlet valve repeatedly opens completely and closes completely to maintain air discharge pressure within a certain range. When the inlet valve is open, the compressor generates its full-load air output. When the inlet valve is closed, the compressor generates no compressed air. The valve opens when discharge air pressure drops to a low setpoint, indicating air demand needs to be met. The valve then closes when pressure reaches a high setpoint, indicating air demand has momentarily been met. When “unloaded” and generating no compressed air, rotary-screw compressors draw between 30% and 60% of full-load power, but most commonly draw around 50% of full-load power.

Reciprocating compressors also operate in a load/unload fashion. They unload by turning off and evacuating compression chamber cylinders. This method of unloading is significantly more efficient than a rotary screw compressor’s method. Reciprocating compressors only draw between 20% and 30% of full-load power when unloaded.

We were unable to monitor compressor power during our visit. Figure 3-3, however, shows the power profile of a rotary screw air compressor at a different plant. Figure 3-4 shows the amperage (directly proportional to power) profile of a reciprocating compressor at a different plant. Note that the reciprocating compressor has a much lower unloaded power draw with respect to its loaded power than does the rotary screw compressor.

Figure 3-2
Sample Rotary Screw Compressor Power Profile

Figure 3-3
Sample Reciprocating Compressor Power Profile



Because reciprocating compressors have greater part-load efficiency than rotary screw compressors, the most efficient staging arrangement would be to sequence the compressors in a way such that the reciprocating compressor always runs part-loaded as trim, and the rotary screw compressors always run fully-loaded.

Automatic sequencers are commercially available that can control an entire compressed air system based on pressure in the compressed air header. A sequencer, in this case, can be programmed to operate the reciprocating compressor as full-time trim, and only operate the rotary screw compressors fully-loaded.

For process air, one compressors is 110-kW Ingersol Rand rotary screw compressor with an output capacity of 19 m3/min. The two of four compressor are an older reciprocating compressor driven by a 130-kW motor. In order to meet air demand of 47 m3/min at pressure of 2.5-3.2kg/cm2, three compressors operate at pressure of 5.5kg/cm2 or even higher.

3.7.2. RECOMMENDATION

Compressed air demand	Rotary screw compressor operation	No1 Reciprocating compressor	No2 Reciprocating compressor
Demand <21.5m^3/min	off	off	Part-loaded
21.5m^3/min<demand<40.5m^3/min	Fully-loaded	fully -loaded	off
40.5m^3/min<demand<62m^3/min	Fully-loaded	fully -loaded	Part-loaded

Automatic sequencers are widely available, and may be able to be purchased from the Ingersol Rand distributor.

We were unable to monitor compressor power draw during our visit. However, Table 3-11 shows a potential loading scenario based on compressed air demand magnitude and percentage of time that demand is at a particular magnitude. For each compressed air demand magnitude, the power draw of each compressor is calculated based on the current staging arrangement. The calculations assume the rotary screw compressors draw 50% of full-load power when unloaded, and the reciprocating compressors draw 30% of full-load power when unloaded.

Table 3-11
Compressed Air Demand and Energy Consumption Scenario for Current Compressor Staging

Total compressed air demand(m3/min)	Rotary screw compressor		#1 reciprocating compressor		#2 reciprocating compressor		Power sum(kW)	Annual energy (kWh)
	Output(m3/min)	Power draw(kW)	Output(m3/min)	Power draw(kW)	Output(m3/min)	Power draw(kW)		
47	19	110	21.5	130	6.5	60	300	2,400,000

The same analysis was done for the proposed staging arrangement - the results are shown in Table 3-12.

Table 3-12
Compressed Air Demand and Energy Consumption Bin Scenario for Proposed Compressor Staging

Total compressed air demand(m3/min)	Rotary screw compressor		#1 reciprocating compressor		#2 reciprocating compressor		Power sum(kW)	Annual energy (kWh)
	Output(m3/min)	Power draw(kW)	Output(m3/min)	Power draw(kW)	Output(m3/min)	Power draw(kW)		
47	19	110	14	90	14	90	290	2,320,000

The difference in total annual energy use between the two scenarios is 80,000 kWh. At a rate of ¥0.52 per kWh, the annual cost savings would be approximately ¥41,600.

For process air, in order to meet air demand of 47 m3/min at pressure of 2.5-3.2kg/cm2, we recommend to check the range of the demand air pressure and recommend that three compressors should operate at pressure not greater than 3.8 kg/cm2. Compressor's operation pressure can be decreased by almost 2 kg/cm2.. Based on past experiences, 6% of energy saving can be achieved when operation pressure is decreased by 1kg/cm2. Therefore, energy saving can be around 12%. The annual energy saving can be around 278,400kWh(290kW*12%*8000h). Annual cost saving would be ¥144,768.

For instrument air, in order to meet air demand of 32 m3/min at pressure of 5-5.5kg/cm2, we recommend to check the range of the demand air pressure and recommend that three screw compressors should operate at pressure not greater than 6 kg/cm2. Compressor's operation pressure can be decreased by almost 0.5 kg/cm2.. Based on past experiences, 6% of energy saving can be achieved when operation pressure is decreased by 1kg/cm2. Therefore, energy saving can be around 3%. The annual energy saving can be around 50,400 kWh (210kw*3%*8000h). Annual cost saving would be ¥26,208.

3.7.3. Implementation Cost

The cost to install a sequencer varies depending on the compressor arrangement and electrical arrangement. From past experience, we estimate that it may cost approximately ¥150,000 to install a sequencer for this project.

3.8 MOVE PRODUCTION OF SODIUM HYDROXIDE FROM THE OLD FACILITY TO THE NEW FACILITY

Description:	In 2005 a new Jiangshan Facility was opened outside Nantong. The old facility continues to operate to generate sodium hydroxide at a higher energy consumption then the new plant. By expanding production at the new plant significant savings will be realized.
Action:	Accelerate the transfer of Sodium hydroxide production from the old plant to the new plant.
Recommendation:	This EEM requires further study to determine the costs associated with the ramp-up of production at the new facility.

ENERGY IMPACTS

Total Cost (¥)	Annual Energy Savings (kWh)	Annual Cost Savings (¥)		
200,000,000	**14,352,000**	**7,463,040**		
			Simple Payback (years):	**?**

3.8.1. DISCUSSION

At the end of 2005 Jiangshan Agrichemical and Chemical Co. opened a new facility covering 690,000 square meters. When the build-out of this facility is complete it is estimated that the plant will have the capacity to produce 300,000 tons of sodium hydroxide, 60,000 tons of glyphosate, and 350,000 tons of PVC per year. Facility personnel reported that the old facility produced 92,000 tons of sodium hydroxide in 2005 at an average energy consumption of 2,561 kWh/ton. The new facility in 2006 produced 62,385 tons of sodium hydroxide at an average cost of 2,405 kWh/ton using the more efficient Ion Exchange Membrane Cell Electrolysis Process.

3.8.2. RECOMMENDATION

Based on the 6% increase in production efficiency associated with the new facility it may be beneficial to speed-up the development of the new facility and move all sodium hydroxide production to that location. To fully justify this measure much more information regarding the anticipated construction costs, moving costs, and de-commissioning costs associated with the old plant would have to be studied.

3.8.3. ENERGY AND COST SAVINGS

Initial reports on the energy consumption of sodium hydroxide manufacturing indicate that there is a reduction in energy consumption of 156 kWh/ton associated with utilizing the new Ion Fume process. If the entire production of 92,000 tons of NaOH were moved to the new facility there would be an energy savings of 14,352,000 kWh/yr and a cost savings of ¥7,463,040 per year.

3.8.4. IMPLEMENTATION COST

It can reasonably be assumed that Jiangshan Agrichemical and Chemical Co. is anticipating the expenditure associated with fully developing their new facility in the next three years. It may however be beneficial to invest any premium funds required to accelerate this development to capture the added energy savings. The incremental increase in cost to accelerate the more must be developed.

4 Best Practices in Energy Efficiency

This section provides Information for the Jiangshan Agrichemical and Chemical Co. on energy-efficiency measures that require further investigation to quantify savings and costs. This section provides information on recent technological advances and best practices for the improving efficiency of energy intensive equipment not examined in detail in Section 3:

- Compressed Air Systems
- HVAC
- Lighting

4.1 Best Practices in Compressed Air Systems

Maintain Pressure at Lowest Possible Level – Greater energy is required to compress air to a higher pressure. Higher pressure compressed air not only is generated less efficiently, but also leaks faster through holes and orifices in the system, thereby causing higher output than necessary.

Compress Coldest Air Possible – Air is denser at lower temperatures, thus requires less energy to compress. For energy efficiency, it is advisable to use the coldest air possible for compression, which in most cases is outdoor air. Outdoor air can be ducted directly to the compressor's intake, or windows/doors/vents can be left open to draw outdoor into the room.

Repair Compressed Air Leaks – Air leaks in a distribution system increase compressed air demand thus increasing a compressor's electrical load.

Operate Rotary-Screw Compressors in Load/Unload Mode – Rotary-screw compressors have two major modes of capacity control: load/unload control, and modulation control. In load/unload control, the compressor's inlet valve repeatedly opens completely and closes completely to maintain air discharge pressure within a certain range. When the inlet valve is open, the compressor generates its full-load air output. When the inlet valve is closed, the compressor generates no compressed air. Sump pressure decreases when unloaded, thus causing the compressor to draw between 40% and 45% of its full-load power.

In modulation control, compressed air output is controlled by the compressor's modulating inlet valve. Power (kW) to the compressor decreases in a linear fashion as air output (scfm) decreases, but only decreases to approximately 70% of its full-load power at the point when it generates no compressed air.

Properly Stage Compressors – In a multiple compressor system, the compressors' operation should be staged so that the compressor with highest part-load efficiency operates as the trim compressor, and the compressors with the lowest part-load efficiencies carry the base load. Reciprocating compressors and variable frequency drive (VFD) compressors have the best part-load efficiency; standard rotary-screw compressors have lower part-load efficiency; and centrifugal compressors have the least part-load efficiency.

Use Electric Motor Tools Instead of Pneumatic Tools when Feasible – According to the U.S. Department of Energy's Compressed Air Challenge Program, compressed air systems are only 10% - 15% efficient. This is due in part to the requirement to reject heat when compressing air, and to the requirement that compressed air exits pneumatic equipment at a velocity greater than zero. Therefore, compressed air is not recommended to produce work if electric motors (about 90% efficient) can alternately be used.

Several pneumatic tools are used in the facility's. It is up to the discretion of management whether any pneumatic equipment can be replaced by electric alternatives.

4.2 Best Practices in HVAC

Buildings that support the Jiangshan Agrichemical and Chemical Co., particularly offices, control rooms, and break rooms have heating, ventilation, and air conditioning (HVAC) systems. The following are best practices in HVAC.

Temperature Setback – Setpoint temperatures can be set back during cold season, and set forward during warm season when a room is unoccupied for long periods of time. Doing so reduces building heating and cooling load. For example, office room temperatures can be setback during night hours. To better control temperature setback, programmable thermostats can be installed to automatically setback temperature based on time of day.

Do Not Overventilate – According to building standards, a minimum of 0.57 cubic meters per minute (cmm) of fresh outdoor air is required per person occupying a commercial or office building. Ventilation rates significantly higher than 0.57 cmm cause more outdoor to be conditioned than necessary. Typically, ventilation rates can be turned down in an office building at night when not occupied. To better control ventilation rates, a demand control ventilation (DCV) system can be installed that controls ventilation based on monitored CO2 levels within the building.

Utilize Economizer Controls – Due to internal sources of heat such as machinery, people, electronics, etc., buildings often require cooling even on moderately cool days. If large amounts of cool outdoor air are brought into a building during those types of days, little or no mechanical cooling would be necessary to meet the cooling load. Economizer controls perform this function by controlling outdoor air intake based on outdoor temperature to minimize mechanical cooling. In a system with economizer controls, outdoor air intake is maximized during moderately cool days, and minimized during cold days and hot days.

Employ Variable Air Volume (VAV) System Rather than Constant Air Volume (CAV) System – A constant air volume (CAV) system delivers air to each zone in an HVAC system at a constant flow rate. Because supply air flow is constant, it often needs to be both heated and cooled (particularly during moderate temperature days) in order to balance its temperature to the zone setpoint. Simultaneous heating and cooling is inefficient.

A variable air volume (VAV) system varies the amount of air delivered to each zone based on the heating or cooling load. Supply air flow is highest during peak heating and cooling days, and lowest during moderate temperature days. Varying supply air minimizes the need to simultaneous heat and cool.

Use Variable Speed Supply Fan in VAV System – A variable speed supply fan is ideal for a variable air volume (VAV) system. A variable frequency drive (VFD) can be installed on a fan motor to allow for variable speed. Without a variable speed supply fan, inlet air dampers would need to be employed, which build fan pressure and result in inefficiencies. Slowing a fan down when less flow is needed is the most efficient method of flow control.

4.3 Best Practices in Lighting

The Jiangshan Agrichemical and Chemical Co. utilizes lighting in the offices, in the process buildings, and on the connecting roadways. The following are best practices in lighting.

Super T8 Fluorescent Technology – In general it is recommended that T12 fluorescent lamps and magnetic ballasts be replaced with standard T8 lamp and electronic ballast combinations. However, new “Super T8” technology is now available for 4-foot linear T8 systems that offer even greater energy and demand savings than the standard T8 replacement.

Advanced T8 lighting systems consist of high-lumen, high CRI, extended-life T8 lamps used in combination with matched “program-start” low ballast factor electronic ballasts. This lamp and ballast combination offers system efficacies (Lumens/Watt) approximately 15-20% higher than standard T8 systems. The lamps used in Super T8 systems have at least 20% longer lamp life than standard T8 lamps, decreasing maintenance costs. The incremental cost for Super T8 vs. standard T8 is about 8 rmb per lamp and 62 rmb per ballast.

Compact Fluorescents – Compact fluorescent lights (CFL’s) are premium-efficient lights designed to replace incandescent lights. CFL bulbs typically draw between 13 and 20 watts, as compared with incandescent bulbs that draw between 50 and 100 watts. CFL’s, by design, output equal or greater light than their corresponding incandescent bulbs. In addition, CFL bulbs last about 10,000 hours, whereas incandescent bulbs last about 1,000 hours.

High Bay Fluorescent Lights – High-bay fluorescent (HBF) lights, which typically consist of six 4-ft T8 lamps in specially-designed high-efficiency fixtures, are an energy-efficient alternative to high intensity discharge (HID) lights. The high-bay fluorescents lights draw about 227 W per fixture while putting out the same lumens as a HID light that draws 450 W. In addition, the color-rendering index (CRI), a measurement of light quality (daylight having a CRI of 1), of a HBF fixture is 0.85 as opposed to 0.65 for HID lights. The experience of most industrial clients who have switched from HID to HBF lighting has been overwhelmingly positive. The areas under the new lights are visibly brighter, and workers report that they can see better with the new lights.

Occupancy Controls – Occupancy controls can be used to dramatically reduce operating hours of certain types of lighting fixtures. Occupancy sensors activate lighting when someone enters the space. When the space is vacated, an adjustable delay mechanism turns off the lights after a selected time period. All occupancy sensors incorporate field adjustable time delays so that the lights will not immediately turn off when someone leaves the area. This prevents unnecessary cycling of the lighting and allows a worker in a location hidden from the sensor to finish their task before the lights turn off. In addition, most sensors incorporate field adjustable sensitivity so that the reach of the sensor will not turn the lights on when there is movement in an adjoining area.

Daylight Harvesting Sensors – A daylight-harvesting sensor senses the amount of available daylight, and turns off lights when an adjustable daylight threshold is obtained. An adjustable “lag” prevents the fixture from cycling quickly during variable daylighting conditions. This system is also used in buildings that incorporate skylights or monitors for daylighting. Another efficient design using this system involves controlling lighting fixtures within 10’ of glazed exterior walls, while the rest of the lighting fixtures in the space are controlled by other means.

5 Economic and Financial Analysis

We conducted an economic and financial analysis of the energy-efficiency measures (EEMs) studied in Section 3. Using the performance estimates for the EEMs, we projected the lifetime benefits as the marginal electricity supply costs that the power grid would avoid. We compared the present worth of EEM benefits with their costs to determine cost-effectiveness. The financial analysis considers the EEM as a financial investment by the customer by comparing the cash flows that would result from electricity bill savings with the initial outlay made by the customer to pay for it. EPP financial incentives to the customer reduce the customer's initial outlay for the EEM, which make the cash flow from bill reductions more financially attractive.

Based on this cash-flow analysis of cost-effective EEMs, we develop and recommend financial incentives that bring down the Facility's initial outlay low enough to make the bill savings pay for its EEM investments in about a year. In effect, the incentive recommendation would allow the facility to pay for all the recommended EEMs out of its operating budget.

Table 5-1 presents the results of our economic and cashflow analysis of various sets of EEMs with the financial incentives that we recommend JA&C consider for various combinations over time. (Separately we provide the Microsoft Excel workbook files with the economic and cashflow analysis for each EEM package.) Note that the S11 analysis should only be considered representative. We recommend that JA&C further evaluate the technical suitability and cost-effectiveness of S13 transformers compared to the S11 series, given the likelihood that S11 will become standard practice soon and the domestic availability of S13 transformers. If suitable and cost-effective compared to S11 technology, we recommend that JA&C develop a financial incentive that brings the Facility's investment down far enough to pay for itself with one year of electricity savings as shown for S11 transformers in Table 5-1.

We also recommend that JA&C estimate the costs for modernizing the Sodium Hydroxide process. The potential electricity savings and benefits exceed the total of all of the other EEMs combined. The economic analysis indicates present worth benefits at 51.3 million RMB. If the costs are less than 51 million RMB, then this measure would be cost effective. Whether this decision would be financially worthwhile for the Company would depend on whether the project is cost-effective enough to allow JETC to offer financial incentives large enough to buy the modernization down to a one-year payback period for JA&C.

Table 5-1
Summary of Jiangshan Agrichemical and Chemical Company Efficiency Measures Economic and Cash Flow Analysis

	Motor Retrofit	Motor Scheduled Replacement	Variable Frequency Drive	Synchronous Belts	Downsize Motor Retrofit	Downsize Motor When Replaced	Scheduled Transformer Replacement	Compressed Air Leak Repair	Optimize Compressors	EPP Package 1	Under 1-Year Payback Package	All Retrofit Package	Lost Opportunity Package	Total All Measures
	[1]	[1a]	[2]	[3]	[4]	[4a]	[5]	[6]	[7]	[1]+[2]+[3]+[4]	[6]+[7]	[1]+[2]+[3]+[4]+[6]+[7]	[5]	[1] to [7] without [1a] & [4a]
Total Measure Cost (not discounted)	¥2,463,923	¥429,607	¥3,454,500	¥1,006,341	¥680,841	-¥500,738	¥295,500	¥40,000	¥150,000	¥7,605,604	¥190,000	¥7,795,604	¥295,500	¥8,091,104
Incentive										¥3,194,353	¥0	¥3,274,153	¥124,110	¥3,398,263
% of Total Measure Cost										42%	0%	42%	42%	42%
Customer Contribution										¥4,411,250	¥190,000	¥4,521,450	¥171,390	¥4,692,840
EPP Economic Analysis														
Benefits (Avoided Generation, T&D)	¥6,012,107	¥4,762,152	¥15,113,595	¥3,848,924	¥3,035,688	¥2,404,549	¥2,475,990	¥64,337	¥1,464,581	¥28,010,315	¥1,528,918	¥29,539,233	¥2,475,990	¥32,015,223
Total Costs (see Note)	¥1,387,356	¥340,289	¥3,454,500	¥1,006,341	¥55,545	-¥396,632	¥295,500	¥40,000	¥150,000	¥5,903,742	¥190,000	¥6,093,742	¥295,500	¥6,389,242
Net Economic Benefits	¥4,624,751	¥4,421,863	¥11,659,095	¥2,842,584	¥2,980,143	¥2,801,181	¥2,180,490	¥24,337	¥1,314,581	¥22,106,573	¥1,338,918	¥23,445,491	¥2,180,490	¥25,625,981
Benefit/Cost Ratio	4.33	13.99	4.38	3.82	54.65	(6.06)	8.38	1.61	9.76	4.74	8.05	4.85	8.38	5.01
CDM-CER Present Value (max 10 years)	¥775,122	¥775,122	¥2,105,451	¥496,003	¥391,813	¥391,813	¥162,637	**Not applicable**		¥3,768,389		¥3,768,389	¥162,637	¥3,931,026
% of Total Measure Cost	31%	180%	61%	49%	58%	-78%	55%			50%		48%	55%	49%
% of Customer Contribution										85%		83%	95%	84%
Customer Cash Flow Analysis														
Simple payback without incentive	2.82	0.49	1.46	1.80	1.54	Not applicable	1.61	0.45	0.71	1.79	0.63	1.72	1.61	1.71
Simple payback with incentive										1.04	0.63	1.00	0.94	0.99
Internal Rate of Return without incentive	36%	206%	71%	58%	67%	Not applicable	65%	121%	145%	58%	142%	60%	65%	60%
Internal Rate of Return with incentive										99%	142%	102%	110%	103%

Note: Total Costs in EPP Economic Analysis reflect early retirement cost credit for postponing future scheduled replacements.
Benefits and costs in EPP Economic Analysis are all discounted to 2007.

5.1 EEP ECONOMIC ANALYSIS

We analyzed the economics of the electricity savings estimated for several packages of EEMs as substitutes for the electricity supply they would avoid. Electric energy savings avoid coal-fired generation on the margin; peak demand savings avoid transmission and distribution capacity costs. We estimated these benefits over the life expectancy of the electricity savings using information from the DSM Center on electricity supply costs. We compared the present worth of these avoided supply costs with the total costs of the EEMs over their lifetime.

We also estimated the potential proceeds from possible sales of Certified Emission Reductions (CER) under the Clean Development Mechanism (CDM) of the Kyoto Protocols on climate change. We used a value of ¥71.47 per metric ton of CER sold, based on a review of current trading prices paid. We calculated the present worth of proceeds from 10 years of CER sales or the measure life, whichever is shorter.

For motors and transformers, the first step of the economic analysis was to compare the benefits and costs of choosing high-efficiency upgrades at the time of scheduled replacement of the existing equipment. All EEMs at this first stage of the economic analysis were found to be cost-effective.

For motors, we next analyzed the alternative of early retirement of existing machinery before the end of its life expectancy. All of the motors were cost effective to retire early. We then compared the net benefits of early retirement against the net benefits of scheduled replacement. This analysis revealed that for the majority of motors, early retirement would be more cost-effective than waiting to upgrade efficiency at the time replacement would otherwise normally take place. Selecting those motors that are more cost effective to upgrade at the time of natural replacement would only produce a 1.6% increase in net benefits over early retirement of all of the motors. Because of the possibility of missing the opportunity to upgrade the motor efficiency at a later date and the small additional net benefits of waiting for those few motors to be replaced, we recommend early retirement of all of the motors. We assembled these cost-effective early retirements into the Motor Retrofit package and compared their benefits and costs.

Some of the motors were also analyzed for downsizing. These were similarly reviewed for either early retirement or scheduled replacement. Again, the vast majority of motors were more cost effective to early retire than to wait for the time of natural replacement. Selecting those motors that are more cost effective to upgrade at the time of natural replacement would only yield 4% more in net benefits than early retirement of all of the motors examined for downsizing.

For comparison, the results are also shown for upgrading the motor efficiencies and downsizing for all of the motors at the time of their natural replacement. These are shown in Table 5-1 in the columns labeled “Motor Scheduled Replacement” and “Downsize Motor When Replaced.” Since we recommend early retirement of all of the motors over waiting for the time of scheduled replacement, these costs and benefits are not included in the Total All Measures package.

Variable Frequency Drives, Synchronous Belts, Compressed Air Leak Repair, and Optimize Compressors were all treated as retrofits. All of the motors considered for variable frequency drives (VFDs) and synchronous belts were found cost effective except for two VFDs and two synchronous belts. The cost-effective synchronous belt retrofits all had annual operating hours exceeding 3000. A combination of factors caused the two VFDs to fail cost effectiveness. Only the cost-effective VFDs and synchronous belts were included in the final packages.

Following are further details of the economic assessment of efficiency measure packages:

Motor Retrofit: Early retirement of existing motors rather than waiting to replace the motors at the end of their lifetimes. Each of the motors with different remaining lifetimes and characteristics was screened separately to determine if it was more cost effective to retrofit or wait until the end of motor life.

Economic analysis of early retirement must consider two factors. The first is the future decline in initial energy savings that occurs when the existing equipment would have been replaced anyway with new technology that is more efficient than the existing model but less efficient than the high-efficiency EEM installed now. The second factor that must be accounted for in the economic analysis of early retirement is its effect on the future timing of scheduled replacement. By interrupting the normal replacement schedule, early retirement postpones all future replacement investments by the age of the existing equipment. For example, retiring early a 10-year-old motor with five years of life remaining will push back for 10 years the next scheduled motor replacement (and all subsequent replacements thereafter). The deferral of these future investments is a cost savings that is credited to the present worth of the total measure cost of the retrofit.

Motor Scheduled Replacement: Upgrade in motor efficiency by waiting until the end of its lifetime.

The difference in efficiency between the baseline Y-series motors and the high-efficiency YX alternative motor was the primary factor that determined whether retrofit or waiting until the end of the motor life produced greater net benefits. The difference in efficiencies varied by motor size. Motors with a greater difference in efficiency between the baseline and efficient motor tended to favor early retrofit.

Downsize Motor Retrofit: Early retirement of existing motors and replace with smaller more efficient motors rather than waiting to replace the motors at the end of their lifetimes. Each of the motors with different remaining lifetimes and characteristics was screened separately to determine if it was more cost effective to retrofit or wait until the end of motor life.

Downsize Motor When Replaced: Downsize and upgrade in motor efficiency by waiting until the end of the existing motor lifetime.

S11 Transformers: The existing transformers are considered to be near the end of their useful lifetimes, so this measure was examined as a scheduled replacement, rather than an early retirement. The costs and savings were therefore incremental to the new baseline S9 transformers rather than the existing S7 transformers. We question the economics of the S11 transformer upgrade at scheduled replacement because the technology is rapidly gaining widespread market acceptance. If the market norm is indeed S11, then no additional savings can be attributed to the EEM for EPP planning (or for CDM sales of certified emission reductions). Consequently, we recommend further study of the technical suitability, performance and costs of S13 technology before committing to EPP promotion of S11 transformers.

5.2 Customer Cash Flow Analysis and Financial Incentive Development

The cashflow analysis valued the electricity savings from EEMs according to the relevant electricity tariff. These cashflows were evaluated and compared to the outlay the company would have to make absent any EPP financial incentive. We computed the simple payback period for each EEM and EEM package considered in the economic analysis. This indicates how long it would take the annual electricity bill savings to pay for the customer’s total measure cost. We also computed the rate of return the casfhlows would produce based on the customer’s initial outlay for the EEMs at their full measure costs. This rate of return is a better indicator of the long-term financial performance of the customer’s EEM investment compared to competing investment opportunities available elsewhere in the enterprise.

Cost-effective EEMs offer JA&C simple payback periods ranging from 0.5 years (i.e. four months) for repairing compressed air leaks to 2.8 years for replacing inefficient motors. The rate of return JA&C would earn from investing in each EEM ranges from 36% for motor retrofit upgrades to 145% for optimizing compressors.

EEMs with payback periods longer than one year require the customer to raise capital either from internal or external sources. Once the customer contribution toward the investment falls below one year, it means that no capital budgeting is necessary and that the customer could justify using its operating budget to pay for the EEMs. This leads to two complementary recommendations. First, we recommend that the utility not offer financial incentives for EEMs with simple payback periods shorter than one year. Second, we recommend that the utility offer financial incentives for cost-effective EEMs with payback periods longer than one year that are structured to “buy down” the customer’s contribution an amount that would yield a one-year simple payback on its EEM investment.

Table 5-1 shows the financial incentives we recommend for the various packages assembled from each of the EEM components in order to provide JA&C with a one-year payback period. The incentive is shown both in RMB and as a percentage of the total measure cost. The recommended financial incentives range from ¥0 for the less than one-year payback measures up to ¥3.4 million for all of the measures. As a percentage of total measure cost, these recommended incentives range from 0% to 42%.

The last five columns of Table 5-1 show the financial incentives, payback period, and rate of return on customer investment for the five different packages of EEM composed of the individual EEM elements in the first seven columns. This shows that EPP Package 1, consisting of early motor retirement, variable frequency drives, synchronous belts and motor downsizing, would provide JA&C with a financial incentive of ¥3,194,353, covering 42% of the total measure cost.

Table 5-1 shows the customer cashflow analysis if JA&C pursues both EPP Package 1 and the two EEMs that pay for themselves in less than a year (the All-Retrofit Package). With only an additional financial incentive of ¥79,800 beyond EPP Package 1, JA&C would nudge the payback period to just under a year and an annual return on investment of 103% over the life expectancy of all the EEMs installed. We therefore recommend that JETC strongly encourage JA&C to pursue this option, even going so far as to make investment in both of the Under 1-Year Payback EEMs as a condition for receiving an incentive for EPP Package 1.

Depending on the economics of S13 vs. S11 transformers, we recommend that JETC offer JA&C a total of ¥124,110 for the imminent replacement of transformers. This would yield JA&C a simple payback of just under 1 year instead of 1.6 years without the recommended incentive, and a rate of return of 110% with the incentives instead of 65% without them.

The last column of Table 5-1 shows that the combination of incentives for all the EEMS analyzed would defray about 42% of the total measure costs, requiring a total contribution by JA&C of ¥4,692,840. This investment would yield a customer payback period of one year, and a return on its investment of 103% per annum. This should prove extremely financially attractive to JA&C, enough so to garner maximum net economic benefits for Jiangsu and its power grid.

Finally, Table 5-1 provides the estimated present worth of ten years of CER sales under CDM. Because the Under 1-Year Payback measures are so financially attractive to JA&C without any financial incentive, we doubt seriously that these EEMs would qualify for CDM. For the other EEMs and packages, potential CER proceeds at expected market trading prices could offset much of the customer contribution by JA&C after JETC financial incentives. For example, CER proceeds would cover anywhere from 83% of the customer contribution after JETC financial incentives up to 95%. The present worth of CER sales would offset 83% of JA&C's required customer contribution for the All Retrofit package and for all measures combined. CDM proceeds would account for about 85% of that required for EPP Package 1 and 95% of the lost-opportunity package. This analysis clearly indicates that pursuing these recommended EEMs as CDM projects would be highly attractive for Jiangsu and JA&C.

6 Measurement and Verification

Efficiency programs commonly include a measurement & verification (M&V) process to assure that specific efficiency projects and tasks have been carried out and are performing effectively. An M&V process involves site inspections of implemented projects that have received incentives through the efficiency program. Site inspections consist of documenting project installations, and often measuring to determine the facility's performance improvement after retrofit.

M&V processes are essential in determining the success of an efficiency program. Post-retrofit measurements establish the difference between theoretical projected energy savings and actual savings. Program incentives may then be modified based on realized actual savings. Repetitive problems are often discovered through the M&V process, which can be dealt with and solved. Solving problems and identifying strong and weak points is an effective way to fine tune a program. Moreover, sound M&V procedures will be absolutely necessary if it is intended to pursue CER sales through the CDM mechanism.

M&V processes have added much value to efficiency programs in New England and California. The following steps illustrate a typical M&V procedure.

Review Project Files – Invoices and documents regarding approval of efficiency projects are reviewed.

Decide Which Sites to Evaluate – Based on client type and what energy-efficient equipment each client installed, a sample of clients is chosen for evaluation. The sample selected should represent the program's entire client population with 10% relative precision.

Visually Inspect Sites – Verify that the implemented projects are consistent with project files. On site inspections, decide which pieces of equipment should be logged.

Install Loggers – Loggers should be installed on new pieces of equipment or upgraded equipment. Equipment should be logged for a period of one to four weeks.

Analyze Data – Data analysis determines energy savings. Volatile factors such as daily operating hours, building occupancy level, and weather conditions should be taken into account during analysis.

Determine Savings – Savings are determined by comparing the energy use and performance of an efficient system with the performance of standard baseline system.

Submit Report – The evaluation report is submitted to program management. The report includes a comparison of projected savings before project implementation and savings based on measurements after implementation.

Reported results help determine the effectiveness of an efficiency program, and help recommend possible improvements.

Appendix 8.2 provides two detailed sets of M&V procedures for EEMs addressing two types of motor loads: (1) constant loads, which is the predominant type of motor load at JA&C; and (2) variable loads leading motors to operate at partial capacity

7 Conclusions and Recommendations

Here we consolidate and reiterate the conclusions and recommendations from our technical, economic, and financial analysis of the 7 EEMs examined in this study.

7.1 Technical Assessment

We find that all EEMs studied are technically feasible. We conclude that they will save over 9 million kWh annually, and recommend that JA&C install them all as soon as possible. Each EEM is summarized below.

7.1.1. EEM-1 Replace JO2-Series and Y-Series Motors with YX-Series Motors

Most plant motors are standard-efficiency Y-series motors. Premium-efficiency YX-series motors are commercially available, and are between 1% and 3% more efficient than standard-efficiency motors. We recommend replacing Y-series with YX-series motors.

7.1.2. EEM-2 Install Variable Frequency Drives (VFDs)

Although production at the facility is nearly constant, many of the motor-driven loads are variable due to throttling that occurs in the processes, or due to seasonal variations in temperature or humidity. Slowing motor revolutions down when the motors are not fully loaded can result in significant energy savings. We recommend installing VFD’s on motors with centrifugal loads that vary more then 10%.

7.1.3. EEM-3 Replace Standard V-Belts with Synchronous Belts on Belt Driven Loads

Standard V-belts have been shown to have an efficiency of approximately 92%, indicating that approximately 8% of the work produced by the motor is lost as heat as the belts flex and slip going around the pulleys. Over time the efficiency of V-belts deteriorates due to wear and incorrect tensioning. Synchronous belts are available on the market that are similar to the timing belt on modern cars. These belts have raised ridges perpendicular to the length of the belt that lock into corresponding grooves machined into the sprockets similar to the meshing of gear teeth. Synchronous belts have an efficiency of approximately 98%.

Synchronous belts require the replacement of both the belts and the sheaves for utilization.

7.1.4. EEM-4 Replace Oversized Motors with Correctly Sized, Efficient Units

It was noted from information provided by the facility that many of the site motors are operating at less then 50% of rated capacity. Generally motors are designed to operate at peak efficiency when approximately 75% loaded. When motor load drops below 50% the motor efficiency and power factor drops significantly. For example: a 55 KW motor that operates at 92.5% efficiency when 75% loaded will operate at 87.1% efficiency at 25% load. It is recommended that motors that are consistently loaded at less then 50% be replaced by correctly sized YX-Series motors.

7.1.5. EEM-5 Consider Installing S11 Transformers When Replacing Existing Transformers

Jiangshan Agrichemical and Chemical Co. is considering replacing several old style S7 transformers that are approaching their end of life. Three major types of transformers are commercially available: standard-efficiency S9 transformers, high-efficiency S11 transformers, and premium-efficiency S13 transformers. S13 transformers are most efficient because they undergo the least core losses but may not be readily available at this time. We recommend considering installing S11 and if possible S13 transformers when replacing existing transformers.

7.1.6. EEM-6 Repair Compressed Air Leaks and Maintain Air Distribution System

Compressed air production is very costly from an energy consumption perspective. Due to the very large number of piping connections, seals, valves, pneumatic devices, and controls that are attached to a compressed air system the network of pipe and tubing becomes very complex in a facility of this size. Unfortunately with all the piping and connections there is often a significant portion of overall compressed air production that is lost to leakage. By initiating a comprehensive plan to find and repair leaks on a bi-annual basis large energy savings will result.

7.1.7. EEM-7 Optimize Air Compressor Usage

Rotary screw and centrifugal compressors operate very efficiently at peak loading and inefficiently at part load unless controlled with a VFD. Reciprocating compressors operate very efficiently at part loads, but not at peak loads. To optimize compressed air production it is important to sequence compressor operation so that rotary screw or centrifugal compressors operate at peak load and that reciprocating or VFD controlled compressors operate for trim applications.

7.1.8. FURTHER ANALYZE CONVERTING ALL SODIUM HYDROXIDE PRODUCTION TO ION FUME ELECTROLYSIS

The old facility manufactures 92,000 tons of sodium hydroxide a year at an energy utilization rate of 2,561 kWh/ton using an anode electrolysis process. The new facility generates 63,000 tons per year at a reported energy usage of 2,405 kWh/ton and is anticipated to have the capacity to produce 300,000 tons/yr in the future. By expanding the new process to replace the old process, very significant savings would result. It is anticipated that the total cost to expand the new operation and move production from the old facility to the new facility will cost approximately 200,000,000 RMP. Although energy savings alone may not be enough to justify moving this operation, it may be an incentive to accelerate the transition if the move is ultimately planned for the future.

Comprehensive economic analysis would be required to determine the costs and benefits associated with accelerating the planned transition to the new facility. Optimizing the timing of the transition would require a detailed analysis that was beyond the scope of this assessment. Consequently, we draw no conclusions and make no recommendations on whether it is economically or financially viable to accelerate the transition to the new facility.

7.2 ECONOMIC AND FINANCIAL ASSESSMENT

Table 7-1 summarizes the results of the economic and financial analysis of each of the seven EEMs studied and of all seven combined.

Table 7-1: Summary of JA&C EEM Economic and Financial Analysis

	Motor Retrofit	Variable Frequency Drive	Synchronous Belts	Downsize Motor Retrofit	Scheduled Transformer Replacement	Compressed Air Leak Repair	Optimize Compressors	Total All Measures
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	
Total Measure Cost (not discounted)	¥2,463,923	¥3,454,500	¥1,006,341	¥680,841	¥295,500	¥40,000	¥150,000	¥8,091,104
Recommended Incentive								¥3,398,263
% of Total Measure Cost								42%
Customer Contribution								¥4,692,840
EPP Economic Analysis								
Benefits (Avoided Generation, T&D)	¥6,012,107	¥15,113,595	¥3,848,924	¥3,035,688	¥2,475,990	¥64,337	¥1,464,581	¥32,015,223
Total Costs (see Note)	¥1,387,356	¥3,454,500	¥1,006,341	¥55,545	¥295,500	¥40,000	¥150,000	¥6,389,242
Net Economic Benefits	¥4,624,751	¥11,659,095	¥2,842,584	¥2,980,143	¥2,180,490	¥24,337	¥1,314,581	**¥25,625,981**
Benefit/Cost Ratio	4.33	4.38	3.82	54.65	8.38	1.61	9.76	5.01
CDM-CER Present Value (max 10 years)	¥775,122	¥2,105,451	¥496,003	¥391,813	¥162,637	**Not applicable**		¥3,931,026
% of Total Measure Cost	31%	61%	49%	58%	55%			49%
% of Customer Contribution								84%
Customer Financial Analysis								
Simple payback without incentive	2.82	1.46	1.80	1.54	1.61	0.45	0.71	1.71
Simple payback with incentive								0.99
Internal Rate of Return without incentive	36%	71%	58%	67%	65%	121%	145%	60%
Internal Rate of Return with incentive								103%

Note: Total Costs in EPP Economic Analysis reflect early retirement cost credit for postponing future scheduled replacements.
Benefits and costs in EPP Economic Analysis are all discounted to 2007.

7.2.1. ECONOMIC ASSESSMENT

The recommended EEMs all provide energy savings at life-cycle costs well below the avoided cost of coal-fired electricity supply. Maximum economic net benefits to Jiangsu will be realized if JA&C installs all cost-effective EEMs as soon as possible.

The total economically feasible potential for EEP investment at the plant is 9 million kWh/year, with an estimated peak demand reduction of 522 kW. The total (undiscounted) investment required is 8 million RMB. It is expected to yield benefits in the form of avoided generation and T&D costs of 32 million RMB, for net economic benefits to Jiangsu Province of 25.6 million yuan.

We estimated the benefits but were unable to estimate the potential costs of switching the remaining sodium hydroxide manufacturing process over to the ion fume process. We recommend that JA&C examine this option further to determine its likely costs. We further recommend that JETC work with the enterprise to determine the net economic benefits of such a strategy, and to find out if it would provide enough cost-effective savings to warrant a financial incentive large enough to yield the enterprise a one-year payback period on its contribution.

7.2.2. Financial assessment and incentive recommendation

As is typically the case with many other manufacturing enterprises, it is difficult for JA&C plant managers to raise capital needed to finance energy-efficiency investments for EEMs that take longer than one year to pay for themselves. Such investments must compete with other potential investments for inclusion in the corporate capital budget.

Our analysis of JA&C's energy-efficiency investment opportunities found two EEMs – Compressed-air leak repair and compressor optimization – whose annual electricity savings would repay their investment costs in less than one year. Such investments offer JA&C annual returns in excess of 120%. No additional financial incentive is necessary to make these investments more attractive to the enterprise.

Five EEMs offer simple payback periods ranging from 1.5 to 2.8 years. All together they would pay for themselves in 1.7 years. While each offers attractive financial returns, ranging from 36% to 71%, it nevertheless would probably take years before senior management of the enterprise would end up including all of them in the corporate capital budget.

We recommend that JETC offer JA&C up to 3.4 million RMB if the enterprise agrees to install all seven EEMs as part of a coordinated investment plan in the next year. Representing 42% of the total project cost, this incentive would bring JA&C's contribution to 4.7 million RMB, which would pay for itself in one year and earn the enterprise an annual return of 103%. Eligibility for this incentive should be conditioned on implementation of the two EEMs (EEM-6 and EEM-7) offering JA&C simple payback periods of under a year.

Table 5-1 indicates the maximum incentive offer that would be reasonable for other, partial combinations of EEMs.

EEM-1 through EEM-5 may qualify for recognition as Certified Emission Reductions (CERs) under the UN's Clean Development Mechanism (CDM). With simple payback periods under one year, EEM-6 and EEM-7 are highly unlikely to qualify for CDM treatment. Potential proceeds of 3.9 million RMB are possible from implementation of the other five.

We recommend that JETC further examine the prospects for developing the JA&C EPP investment as a CDM project. The proceeds of the sale of CERs could be used to defray JETC's incentive contribution, thus leveraging additional EPP/CDM projects in Jiangsu.

We understand that early retirement of still-functioning equipment raises accounting issues for the enterprise. We recommend that JETC work with JA&C to isolate these issues and develop appropriate accounting treatment with a Chinese accounting expert.

8 Appendix

8.1 MOTOR POWERED EQUIPMENT

Equipment	Quan. (1)	Rated KW (2)	Actual Current Amps (3)	Actual KW (4)	Years in Service (5)	Annual Operating Time (Hour) (6)	Rated Demand kW (7)	Actual Operating Demand kW (8)	Annual Energy Consumption KWh (9)
Sodium Hydroxide									
Vacuum pump	4	22	40	13.2	10	2640	66	39.5	104,253
Lifter	2	7.5	14	4.6	7	5280	15	9.2	48,651
Feeding pump	1	75	140	46.1	8	8000	75	46.1	368,570
Pump for salt dissolving barrel	2	11	20	6.6	8	8000	22	13.2	105,306
Chlorine compressor	4	330	200	105.3	7	8000	990	315.9	2,527,334
Single Stage transfer pump	1	37	70	23.0	7	8000	37	23.0	184,285
Asbestos mixing barrel	2	6.2	4	1.3	9	3000	12.4	2.6	7,898
Pump for dilute alkali	2	22	40	13.2	7	8000	22	13.2	105,306
Chlorine compressor	2	185	270	142.2	3	8000	185	142.2	1,137,300
Two-stage salt extraction pump	1	37	50	16.5	10	8000	37	16.5	131,632
Forced circulating pump	2	110	180	59.2	17	8000	220	118.5	947,750
Three-stage salt extraction pump	1	37	50	16.5	7	8000	37	16.5	131,632
Multistage pump	1	22	40	13.2	4	1320	22	13.2	17,375
Three-stage salt extraction pump (discharging)	1	37	50	16.5	12	8000	37	16.5	131,632
Mixing pump	2	18.5	30	9.9	6	8000	18.5	9.9	78,979
Backwashing water pump	1	11	20	6.6	7	660	11	6.6	4,344
Pump for liquid alkali and salt	1	37	50	16.5	7	3960	37	16.5	65,158
Pump for liquid alkali and salt for hydro-extractor	1	15	28	9.2	8	3960	15	9.2	36,488

Equipment	Quan. (1)	Rated KW (2)	Actual Current Amps (3)	Actual KW (4)	Years in Service (5)	Annual Operating Time (Hour) (6)	Rated Demand kW (7)	Actual Operating Demand kW (8)	Annual Energy Consumption KWh (9)
Pump for mother liquid alkali and slat	1	37	50	16.5	6	2640	37	16.5	43,439
Pump for primary liquid	1	15	28	9.2	9	8000	15	9.2	73,714
Pump for refined brine	1	18.5	30	9.9	5	4000	18.5	9.9	39,490
New secondary salt extraction pump	2	37	50	16.5	3	8000	74	32.9	263,264
Pump for fine saline water	1	11	30	9.9	6	Standby			
Pump for thickened slurry	1	37	50	16.5	8	3960	37	16.5	65,158
Pump for black slurry	2	15	28	9.2	3	2640	15	9.2	24,326
Filter press	2	7.5	14	4.6	10	1980	15	9.2	18,244
Hot water pump	2	7.5	14	4.6	17	8000	7.5	4.6	36,857
Hot water pump	1	15	28	9.2	17	Standby			
Pump for salt slurry	1	7.5	14	4.6	17	1980	7.5	4.6	9,122
Water feed pump	2	200	300	158.0	11	8000	200	158.0	1,263,667
Water feed pump for steam injection	1	22	40	13.2	7	8000	22	13.2	105,306
brine pump	1	11	20	6.6	12	5940	11	6.6	39,095
Water injection pump	1	22	40	13.2	7	8000	22	13.2	105,306
Cooling tower	1	11	20	6.6	7	8000	11	6.6	52,653
Water pump	3	18.5	30	9.9	12	8000	18.5	9.9	78,979
Tower of cooled water (medium temperature difference)	1	11	20	6.6	10	8000	11	6.6	52,653
Pump for cooling water	3	66	40	21.1	8	8000	198	63.2	505,467
Saline water pump	2	30	56	18.4	5	8000	30	18.4	147,428

Equipment	Quan. (1)	Rated KW (2)	Actual Current Amps (3)	Actual KW (4)	Years in Service (5)	Annual Operating Time (Hour) (6)	Rated Demand kW (7)	Actual Operating Demand kW (8)	Annual Energy Consumption KWh (9)
Discharge pump for soda ash	1	15	28	9.2	5	660	15	9.2	6,081
Rose blower	2	30	56	29.5	7	8000	30	29.5	235,885
Cooling pump	1	37	0	0.0	12	Standby			
Pump for cooling tower	2	30	56	29.5	5	8000	30	29.5	235,885
Cooling pump	1	45	84	44.2	8	8000	45	44.2	353,827
Backwater pump for hydrogen	2	30	56	29.5	5	8000	30	29.5	235,885
Alkali feed pump	2	37	50	16.5	5	8000	37	16.5	131,632
Pump for enclosed disc filter (pump for dilute alkali)	1	30	56	18.4	8	4000	30	18.4	73,714
Pump for salt slurry	2	15	28	9.2	2	2000	15	9.2	18,428
Pump for alkali water mixing	1	7.5	14	4.6	6	1320	7.5	4.6	6,081
Preheating pump for brine	2	11	20	6.6	2	4000	11	6.6	26,326
Pump for alkali and salt	1	37	50	16.5	5	2640	37	16.5	43,439
Pump for dilute alkali	1	30	56	18.4	2	1000	30	18.4	18,428
Feed pump for dilute alkali	1	75	140	46.1	5	8000	75	46.1	368,570
One-stage feed pump	1	15	28	9.2	7	8000	15	9.2	73,714
Two-stage salt extraction pump	1	30	56	18.4	6	8000	30	18.4	147,428
Three-stage transfer pump	1	37	50	16.5	5	8000	37	16.5	131,632
Force circulating pump	2	150	146	76.9	4	8000	150	76.9	614,985
Secondary salt extracting pump	1	30	56	18.4	5	8000	30	18.4	147,428
Cooling tower of ventilation	1	88	112	36.9	4	8000	88	36.9	294,856
big water feed pump	1	185	250	131.6	7	8000	185	131.6	1,053,056
Water injection pump	1	15	28	9.2	7	8000	15	9.2	73,714
Blower for cooling tower	1	33	60	19.7	7	8000	33	19.7	157,958
Oil pump for hydro-extractor	3	22	40	13.2	6	8000	44	26.3	210,611
Hydro-extractor	3	55	90	29.6	8	8000	110	59.2	473,875
Chloral									
Fluorine alloy pump	1	7.5	14	4.6	5	1320	7.5	4.6	6,081
cooler water tower	2	11	20	6.6	11	8000	22	13.2	105,306
Clarified water pump	2	22	40	21.1	10	8000	22	21.1	168,489
Centrifugal water pump	2	22	40	21.1	3	8000	22	21.1	168,489
Centrifugal pump	2	30	56	29.5	3	8000	30	29.5	235,885
Chloroethylne									
Air compressor	2	130	200	105.3	3	8000	130	105.3	842,445
Freezer	8	250	310	163.2	4	8000	1000	652.9	5,223,158
Freezer	6	132	200	105.3	4	8000	264	210.6	1,684,890
Thickened slurry pump	2	90	168	88.5	3	8000	90	88.5	707,654
Pulverizer	4	37	70	23.0	3	5400	111	69.1	373,177
Crude slurry pump	2	30	56	18.4	3	8000	30	18.4	147,428
Dilute slurry pump	2	75	140	73.7	3	8000	75	73.7	589,711
Circulating pump for cooling water	1	75	140	73.7	3	8000	75	73.7	589,711
High pressure water pump	1	18.5	30	9.9	3	8000	18.5	9.9	78,979
Makeup pump	1	7.5	14	4.6	3	8000	7.5	4.6	36,857

Equipment	Quan. (1)	Rated KW (2)	Actual Current Amps (3)	Actual KW (4)	Years in Service (5)	Annual Operating Time (Hour) (6)	Rated Demand kW (7)	Actual Operating Demand kW (8)	Annual Energy Consumption KWh (9)
Centrifugal pump	13	7.5	14	4.6	14	8000	52.5	32.2	257,999
Cooling water circulating pump	3	15	14	4.6	3	8000	15	4.6	36,857
Delivery pump for clarified liquid	2	18.5	30	9.9	3	8000	18.5	9.9	78,979
Flushing pump	2	15	14	4.6	3	8000	15	4.6	36,857
Mortar pump	2	30	28	9.2	3	8000	30	9.2	73,714
Slurry pump	3	110	180	94.8	3	8000	110	94.8	758,200
Hot water pump	2	55	100	52.7	4	8000	55	52.7	421,222
Water ring pump	3	75	140	73.7	4	8000	150	147.4	1,179,423
Anti-corrosion pump	1	37	70	36.9	12	2640	37	36.9	97,302
Air compressor	2	132	200	105.3	7	8000	132	105.3	842,445
Air compressor	1	75	160	52.7	7	8000	75	52.7	421,222
Vacuum pump	2	30	28	9.2	3	330	30	9.2	3,041
Cooling pump for filtered water	1	15	14	4.6	4	8000	15	4.6	36,857
0℃saline water pump	6	55	90	47.4	4	8000	165	142.2	1,137,300
Acetylene compressor set	3	110	160	84.2	4	8000	220	168.5	1,347,912
-35℃saline water pump	2	55	60	31.6	4	8000	55	31.6	252,733
Makeup pump for saline water	1	15	14	4.6	4	8000	15	4.6	36,857
Water circulating pump	2	15	14	4.6	4	330	15	4.6	1,520
Cleaning pump	3	15	14	4.6	3	8000	30	9.2	73,714
Single compressor	4	396	210	110.6	3	8000	1188	331.7	2,653,701
Alkali pump	3	18.5	35	11.5	3	8000	37	23.0	184,285
Submerged pump	2	7.5	7	2.3	3	8000	7.5	2.3	18,428
Vinyl chloride pump	2	11	20	6.6	3	4000	11	6.6	26,326
Water ring vacuum pump	1	37	70	36.9	2	4000	37	36.9	147,428
Centrifugal double suction pump	2	55	90	47.4	3	8000	55	47.4	379,100
Hot water pump	2	30	28	9.2	3	8000	30	9.2	73,714
Hot water pump	4	55	90	47.4	3	8000	110	94.8	758,200
Canned motor pump	4	44	80	26.3	3	8000	176	105.3	842,445
Centrifugal blower	2	22	40	13.2	3	8000	44	26.3	210,611
Sand pump	2	30	28	9.2	7	8000	30	9.2	73,714
Waste water pump	1	15	14	4.6	3	2000	15	4.6	9,214
Chlorine Hydride									
Concentrated acid circulating pump	2	7.5	7	2.3	3	8000	7.5	2.3	18,428
Diluted acid circulating pump	2	7.5	7	2.3	3	8000	7.5	2.3	18,428
Cooled water tower	3	11	20	6.6	3	8000	11	6.6	52,653
Water ring pump	3	90	160	84.2	3	8000	180	168.5	1,347,912
Cooling water tower	5	55	90	29.6	3	8000	110	59.2	473,875

Equipment	Quan. (1)	Rated KW (2)	Actual Current Amps (3)	Actual KW (4)	Years in Service (5)	Annual Operating Time (Hour) (6)	Rated Demand kW (7)	Actual Operating Demand kW (8)	Annual Energy Consumption KWh (9)
Dimethylester									
Desulfurizing kettle	6	5.5	3.5	1.2	4	7920	33	6.9	54,733
2SK-6B Electric motor	1	11	11	3.6	4	Standby	11	3.6	
Cooling tower	1	5.5	12	3.9	4	7920	5.5	3.9	31,276
Injection pump	3	15	46	15.1	4	7920	45	45.4	359,671
Water circulating pump	2	15	2.2	0.7	4	7920	15	0.7	5,734
W-300 Electric motor	3	30	45	23.7	4	7920	90	71.1	562,964
LQ1200 Electric motor	6	37	30	15.8	4	7920	222	94.8	750,618
LQ3750 Electric motor	3	90	80	42.1	4	7920	270	126.4	1,000,824
Water pump	3	55	90	47.4	21	3000	55	47.4	142,163
Ammonia compressor	2	132	130	68.4	15	6000	264	136.9	821,384
Ammonia compressor	2	180	240	126.4	21	8000	360	252.7	2,021,868
Ammonia compressor	8	190	260	136.9	21	8000	950	684.5	5,475,891
Make-up pump of saline water	1	4	8	2.6	21	400	4	2.6	1,053
Gear oil pump	1	3	6	2.0	21	300	3	2.0	592
Cooling tower	4	17.5	5.8	1.9	21	8000	70	7.6	61,077
Cooling tower	4	7.5	5.8	1.9	21	4000	30	7.6	30,539
Water circulating pump	3	55	95	50.0	18	8700	55	50.0	435,175
Brine water pump	6	30	45	23.7	21	8700	60	47.4	412,271
Brine water pump	5	55	100	52.7	21	8700	165	158.0	1,374,238
Brine water pump	4	37	56	29.5	21	8700	74	59.0	513,049
Phosphorous Tri-Chloride									
Dosing pump of phosphorus dosing tank	3	4	2	0.7	11	5940	12	2.0	11,728
Submerged pump for phosphorus melting	3	5.5	2	0.7	11	990	16.5	2.0	1,955
Submerged pump for phosphorus trichloride	6	5.5	2	0.7	11	660	33	3.9	2,606
Magnetic pump	3	15		0.0	21	7920	30	0.0	0
Kettle	1	7.5		0.0	21	1980	7.5	0.0	0
Back wash pump	2	7.5		0.0	21	7920	7.5	0.0	0
Waste water pump	1	11		0.0	21	2640	11	0.0	0
Wet rough pump	2	11		0.0	21	7920	11	0.0	0
Pump for dry ester	2	11		0.0	21	7920	11	0.0	0
Liquid ring pump	2	11		0.0	21	7920	22	0.0	0
Water ring pump	1	11		0.0	21	7920	11	0.0	0
Back wash pump	2	11		0.0	21	7920	11	0.0	0
Water pump	1	15		0.0	21	7920	15	0.0	0
Water washing pan	1	15		0.0	21	7920	15	0.0	0
Water washing pan	1	18.5		0.0	21	7920	18.5	0.0	0
Vertical centrifugal pump	2	22		0.0	21	2640	22	0.0	0
Synthesis pan	3	66		0.0	21	7920	198	0.0	0

Equipment	Quan. (1)	Rated KW (2)	Actual Current Amps (3)	Actual KW (4)	Years in Service (5)	Annual Operating Time (Hour) (6)	Rated Demand kW (7)	Actual Operating Demand kW (8)	Annual Energy Consumption KWh (9)
Dipterex									
Water circulating pump	1	7.5		0.0	21	7920	7.5	0.0	0
Pulverizer	1	7.5		0.0	19	1320	7.5	0.0	0
ID fan	2	22		0.0	19	2640	44	0.0	0
Clarified water pump	2	15		0.0	19	5280	15	0.0	0
Nash pump	1	15		0.0	19	1320	15	0.0	0
Nash pump	1	22		0.0	19	1320	22	0.0	0
Vacuum pump	10	22		0.0	19	7920	132	0.0	0
Glyphosate									
Triethylamine pump	2	11	7.2	2.4	5	7200	11	2.4	17,060
Pre-dealcoholization pump	1	11	7.2	3.8	4	7200	11	3.8	27,295
Water ring pump for recovery of methyl chloride	2	60	24	7.9	5	2400	60	7.9	18,955
Fine distilled triethylamineliquid pump	2	11	7.2	2.4	5	7200	11	2.4	17,060
Northern pump for dilute methanol	2	11	7.2	2.4	5	7200	11	2.4	17,060
Reflux pump for Methylal	2	11	7.2	2.4	5	7200	11	2.4	17,060
Pump for remaining liquid of fine distillation	2	11	7.2	2.4	5	7200	11	2.4	17,060
Discharge pump for synthesis	2	15	8.4	2.8	5	2400	15	2.8	6,634
External cooling pump for first-stage hydrolyzation	2	11	7.2	2.4	5	7200	11	2.4	17,060
Triethylamine recovering pump	2	11	7.2	2.4	5	7200	11	2.4	17,060
Triethylamine charge pump	2	11	7.2	2.4	5	7200	11	2.4	17,060
Charge pump for evaporation	2	11	7.2	2.4	5	3600	11	2.4	8,530
Hot water pump	2	60	24	12.6	5	7200	60	12.6	90,984
Cooled water pump	2	60	24	12.6	5	7200	60	12.6	90,984
Evaporating vacuum pump	2	44	18.5	6.1	5	7200	44	6.1	43,833
Charge pump for neutralized mother liquid	2	15	8.4	2.8	5	7200	15	2.8	19,903
Vacuum pump for evaporation filtering	2	44	18.5	6.1	5	2400	44	6.1	14,611
Synthesizing kettle	6	37	15	4.9	7	6000	222	29.6	177,703
First-stage hydrolyzation kettle	2	30	12	3.9	5	7200	60	7.9	56,865
Temperature holding kettle for hydrolyzation	2	11	7.2	2.4	5	7200	22	4.7	34,119
Second-stage pre-dealcoholization kettle	2	15	8.4	2.8	4	7200	30	5.5	39,806
Mother liquid neutralizing kettle	1	15	8.4	2.8	4	7200	15	2.8	19,903
Methanol neutralizing kettle	1	15	8.4	2.8	4	7200	15	2.8	19,903
Mother liquid neutralizing pump	2	11	7.2	2.4	5	7200	11	2.4	17,060
Pump for remaining alkali liquid	2	11	7.2	2.4	4	1500	11	2.4	3,554
Gear pump for dilute methanol	2	11	7.2	2.4	4	7200	11	2.4	17,060
Fist-stage pre-dealcoholization kettle	2	11	7.2	2.4	4	7200	22	4.7	34,119
Pump for storage tank of dimethyl	2	11	7.2	2.4	5	1500	11	2.4	3,554

Equipment	Quan.	Rated KW	Actual Current Amps	Actual KW	Years in Service	Annual Operating Time (Hour)	Rated Demand kW	Actual Operating Demand kW	Annual Energy Consumption KWh
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Vacuum pump for acid removing	4	44	30	9.9	5	7200	132	29.6	213,244
Crystallizing vacuum pump	2	15	8.4	2.8	3	7200	15	2.8	19,903
Water circulating pump	2	110	85	44.8	7	7200	110	44.8	322,235
Water circulating pump	1	320	22.5	187.1	5	7200	320	187.1	1,346,803
Dealcoholization charge pump	2	15	8.4	2.8	5	4800	15	2.8	13,269
Pump of dilute alcohol	2	11	7.2	2.4	5	7200	11	2.4	17,060
Crystallizing kettle	38	11	7.2	2.4	5	4800	418	90.0	432,174
Acid removing kettle	19	30	10.5	3.5	7	7200	570	65.7	472,691
FD fan	1	30	11	5.8	7	3600	30	5.8	20,851
ID fan	1	60	24	12.6	7	3600	60	12.6	45,492
Blower	2	22	12	6.3	4	3600	44	12.6	45,492
Centrifugal	5	37	15	7.9	7	3600	185	39.5	142,163
Conveyor	1	15	8.4	2.8	7	3600	15	2.8	9,951
Vacuum pump	2	44	18.5	6.1	5	7200	88	12.2	87,667
Filter pump of 10% glyphosate	3	15	8.4	2.8	5	1500	45	8.3	12,439
Filter pump of 41% glyphosate	2	15	8.4	2.8	5	1500	15	2.8	4,146
Filter press of 41% glyphosate	1	15	8.4	2.8	5	2400	15	2.8	6,634
Filter press of 62% glyphosate	1	15	8.4	2.8	5	2400	15	2.8	6,634
Vacuum filtering gear pump for mixing	2	11	7.2	2.4	5	1500	11	2.4	3,554
Filtering pump of 41% glyphosate	2	22	12	3.9	5	1500	22	3.9	5,923
Additive charge pump	2	11	7.2	2.4	5	1500	11	2.4	3,554
Vacuum pump for mixing	1	44	18.5	6.1	5	3600	44	6.1	21,917
10% glyphosate mixing kettle	2	37	15	4.9	5	4800	74	9.9	47,388
41% glyphosate mixing kettle	4	30	11	3.6	5	4800	120	14.5	69,502
62% glyphosate mixing kettle	3	30	11	3.6	5	4800	90	10.9	52,126
Isopropylamine charge pump	2	11	7.2	2.4	5	900	11	2.4	2,132
62% mixing pump	2	22	12	3.9	2	2400	22	3.9	9,478
Acettochlor									
Pump for waste phosphoric acid	2	15	8.4	2.8	8	1200	15	2.8	3,317
Crystallizing kettle	2	15	8.4	2.8	6	4800	30	5.5	26,537
Etherified water injection pump	1	15	8.4	2.8	8	7200	15	2.8	19,903
Water pump	1	15	8.4	2.8	8	4800	15	2.8	13,269
Action kettle of intermediate layer	1	15	8.4	2.8	9	1200	15	2.8	3,317
Feeding vacuum pump	1	15	8.4	2.8	9	4800	15	2.8	13,269
Discharging vacuum pump	1	15	8.4	2.8	9	4800	15	2.8	13,269

Equipment	Quan.	Rated KW	Actual Current Amps	Actual KW	Years in Service	Annual Operating Time (Hour)	Rated Demand kW	Actual Operating Demand kW	Annual Energy Consumption KWh
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Evaporating condenser	2	15	8.4	2.8	10	4800	15	2.8	13,269
Acylating kettle	4	22	7.2	2.4	10	4800	88	9.5	45,492
Feeding vacuum pump	1	22	7.2	2.4	8	4800	22	2.4	11,373
Acylating kettle	3	22	7.2	2.4	10	4800	66	7.1	34,119
Condensing kettle	2	22	7.2	2.4	2	4800	44	4.7	22,746
Water ring vacuum pump	1	22	7.2	2.4	6	4800	22	2.4	11,373
Cooled water pump	2	22	7.2	2.4	8	4800	22	2.4	11,373
Condensing kettle	4	30	18.5	6.1	3	4800	120	24.4	116,889
Submerged pump	2	30	18.5	6.1	10	4800	60	12.2	58,445
Vacuum pump	1	30	18.5	6.1	8	4800	30	6.1	29,222
Desolventization injecting pump	2	30	18.5	6.1	8	7200	60	12.2	87,667
Condensing kettle	1	22	15	4.9	8	4800	22	4.9	23,694
Saline water pump	2	74	28	14.7	10	4800	74	14.7	70,765
Freezer	5	180	140	73.7	10	4800	900	368.6	1,769,134
Submerged pump	1	11	7.2	2.4	8	1200	11	2.4	2,843
Submerged pump	2	11	7.2	2.4	8	1200	33	7.1	8,530
Phosphorus oxychoride pump	1	11	7.2	2.4	8	1200	11	2.4	2,843
Cooling									
Ammonia compressor	6	180	140	73.7	10	7200	900	368.6	2,653,701
Evaporating condenser	2	11	7.2	2.4	10	7200	22	4.7	34,119
Saline water pump	2	74	28	14.7	10	7200	74	14.7	106,148
Water circulating pump	2	110	90	47.4	10	7200	110	47.4	341,190
Evaporating condenser	1	11	7.2	2.4	7	7200	11	2.4	17,060
Cooled water tower	2	30	10.8	5.7	5	7200	30	5.7	40,943
Lithium bromide hot water pump	1	74	28	14.7	7	7200	74	14.7	106,148
Cooling tower	1	60	24	7.9	5	7200	60	7.9	56,865
Ammonia compressor	8	400	300	158.0	5	7200	2800	1105.7	7,961,103
Evaporating condenser	8	22	9.6	3.2	5	7200	154	22.1	159,222
Saline water pump	4	90	65	34.2	5	7200	270	102.7	739,245
Water circulating pump	2	11	7.2	3.8	5	7200	11	3.8	27,295
Cooled water tower	1	22	8.4	2.8	5	7200	22	2.8	19,903
Water circulating pump	2	150	110	57.9	5	7200	150	57.9	417,010
Boiler									
Primary fan 1 #	1	355	17	9.0	2	3600	355	9.0	32,224
Primary fan 2 #	1	355	17	9.0	2	3600	355	9.0	32,224
ID fan 1 #	1	355	12	6.3	2	3600	355	6.3	22,746
ID fan 2 #	1	355	12	6.3	2	3600	355	6.3	22,746
Secondary fan 1 #	1	185	250	131.6	2	3600	185	131.6	473,875
Secondary fan 2 #	1	185	250	131.6	2	3600	185	131.6	473,875
Air compressor	3	112	160	84.2	2	7200	112	84.2	606,560

Equipment	Quan. (1)	Rated KW (2)	Actual Current Amps (3)	Actual KW (4)	Years in Service (5)	Annual Operating Time (Hour) (6)	Rated Demand kW (7)	Actual Operating Demand kW (8)	Annual Energy Consumption KWh (9)
Steam turbine									
Water feeding pump 1－3＃	3	355	21	174.6	2	7200	355	174.6	1,257,016
Condenser pump 1,2＃	2	22	34	17.9	2	7200	22	17.9	128,894
Injection pump 1,2＃	2	30	44	23.2	2	7200	30	23.2	166,804
Drainage pump 1,2＃	2	15	22	11.6	2	7200	15	11.6	83,402
Water circulating pump 1,2＃	2	450	26	216.2	2	7200	450	216.2	1,556,306
Lift pump 1,2＃	2	55	71	37.4	2	0	55	37.4	0
High-pressure oil pump	1	45	63	33.2	2	40	45	33.2	1,327
AC oil pump	1	5.5	9	3.0	2	80	5.5	3.0	237
DC oil pump	1	5.5	24	7.9	2	10	5.5	7.9	79
Water Demineralizing									
Clarified water pump 1,2＃	2	55	74	39.0	2	7200	55	39.0	280,534
Industrial water pump 1～3＃	3	200	9	74.8	2	0	200	74.8	0
Demineralizing water pump 1～3＃	3	45	70	36.9	2	7200	45	36.9	265,370
Regenerative pump 1～3＃	3	15	19	10.0	2	1500	15	10.0	15,006
Intermediate water pump 1,2＃	2	75	110	57.9	2	1500	75	57.9	86,877
Fire prevention pump 1,2＃	2	75	110	57.9	2	0	75	57.9	0
Sewage pumps for neutralizing pool	2	22	29	9.5	2	800	22	9.5	7,635
Roots blower for neutralizing pool	2	15	24	7.9	2	1200	15	7.9	9,478
Chemical demineralizing pump	1	22	29	9.5	2	0	22	9.5	0
Water intaking pump	3	110	160	84.2	2	3000	110	84.2	252,733
TOTAL	**666**						**25,769**	**11,344**	**79,139,448**
							(10)	(11)	(12)

Notes for 7.1:

1. Quantity of motors installed for this application.
2. Rated KW of motors installed.
3. Average current drawn by motors in amperage as reported by the Facility.
4. Calculated KW draw of application KW = (380 volts) x (Amps) x (Power Factor = 0.85) x (1.732) / (1,000 watts/KW).
5. Age of motor in years.
6. Annual run time of motors.
7. Sum of rated KW for all operating motors.
8. Sum of calculated KW drawn by motors.
9. Annual energy consumption of motors KWh = (operating hours) x (operating demand KW).
10. Sum of calculated KW draw of all operating motors.
11. Total energy consumption of operating motors.
12. Total annual energy consumption of motors.

8.2 POTENTIAL MOTOR REPLACEMENTS

Equipment	Quan. (1)	Installed KW (2)	Number of Motors in Operation (3)	Rated KW (4)	Actual Current Amps (5)	Actual KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Existing Efficiency % (9)	Proposed Efficiency % (10)	Savings KW (11)	Savings KWh (12)	Savings rmb (13)	Cost rmb (14)	Simple Payback (yrs) (15)
Sodium Hydroxide															
Feeding pump	1	75	1	75	140	78.3	8	8000	92.7%	94.7%	1.8	14,275	7,423	14,625	2.0
Pump for salt dissolving barrel	2	22	2	11	20	11.2	8	8000	87.0%	90.3%	0.9	7,520	3,910	4,290	1.1
Transfer pump	1	37	1	37	70	39.2	7	8000	92.2%	93.5%	0.6	4,724	2,457	7,215	2.9
Pump for dilute alkali	2	44	1	22	40	22.4	7	8000	91.5%	93.2%	0.9	7,137	3,711	8,580	2.3
Chlorine compressor	2	370	1	185	270	151.0	3	8000	94.2%	95.8%	5.4	42,849	22,281	72,150	3.2
Two-stage salt extraction pump	1	37	1	37	50	28.0	10	8000	92.2%	93.5%	0.4	3,375	1,755	7,215	4.1
Three-stage salt extraction pump	1	37	1	37	50	28.0	7	8000	92.2%	93.5%	0.4	3,375	1,755	7,215	4.1
Three-stage salt extraction pump (discharging)	1	37	1	37	50	28.0	12	8000	92.2%	93.5%	0.4	3,375	1,755	7,215	4.1
Mixing pump	2	37	1	18.5	30	16.8	6	8000	91.0%	93.0%	0.8	6,346	3,300	7,215	2.2
Pump for liquid alkali and slat for hydro-extractor	1	15	1	15	28	15.7	8	3960	88.5%	91.8%	0.6	2,520	1,310	2,925	2.2
Pump for Primary liquid	1	15	1	15	28	15.7	9	8000	88.5%	91.8%	0.6	5,090	2,647	2,925	1.1
New secondary salt extraction pump	2	74	2	37	50	28.0	3	8000	92.2%	93.5%	0.8	6,749	3,509	14,430	4.1
Water feed pump	2	400	1	200	300	167.8	11	8000	94.2%	95.8%	6.0	47,610	24,757	78,000	3.2
Water feed pump for steam injection	1	22	1	22	40	22.4	7	8000	91.5%	93.2%	0.4	3,569	1,856	4,290	2.3
brine pump	1	11	1	11	20	11.2	12	5940	87.0%	90.3%	0.5	2,792	1,452	2,145	1.5
Water injection pump	1	22	1	22	40	22.4	7	8000	91.5%	93.2%	0.4	3,569	1,856	4,290	2.3
Cooling tower	1	11	1	11	20	11.2	7	8000	87.0%	90.3%	0.5	3,760	1,955	2,145	1.1
Water pump	3	55.5	1	18.5	30	16.8	12	8000	91.0%	93.0%	1.2	9,519	4,950	10,823	2.2
Tower of cooled water (medium temperature difference)	1	11	1	11	20	11.2	10	8000	87.0%	90.3%	0.5	3,760	1,955	2,145	1.1

Equipment	Quan. (1)	Installed KW (2)	Number of Motors in Operation (3)	Rated KW (4)	Actual Current Amps (5)	Actual KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Existing Efficiency % (9)	Proposed Efficiency % (10)	Savings KW (11)	Savings KWh (12)	Savings rmb (13)	Cost rmb (14)	Simple Payback (yrs) (15)
Brine water pump	2	60	1	30	56	31.3	5	8000	92.2%	93.5%	0.9	7,559	3,931	11,700	3.0
Rose blower	2	60	1	30	56	31.3	7	8000	92.2%	93.5%	0.9	7,559	3,931	11,700	3.0
Pump for cooling tower	2	60	1	30	56	31.3	5	8000	92.2%	93.5%	0.9	7,559	3,931	11,700	3.0
Cooling pump	1	45	1	45	84	47.0	8	8000	92.3%	94.1%	1.0	7,791	4,051	8,775	2.2
Backwater pump for hydrogen	2	60	1	30	56	31.3	5	8000	92.2%	93.5%	0.9	7,559	3,931	11,700	3.0
Alkali feed pump	2	74	1	37	50	28.0	5	8000	92.2%	93.5%	0.8	6,749	3,509	14,430	4.1
Feed pump for dilute alkali	1	75	1	75	140	78.3	5	8000	92.7%	94.7%	1.8	14,275	7,423	14,625	2.0
One-stage feed pump	1	15	1	15	28	15.7	7	8000	88.5%	91.8%	0.6	5,090	2,647	2,925	1.1
Two-stage salt extraction pump	1	30	1	30	56	31.3	6	8000	92.2%	93.5%	0.5	3,779	1,965	5,850	3.0
Three-stage transfer pump	1	37	1	37	50	28.0	5	8000	92.2%	93.5%	0.4	3,375	1,755	7,215	4.1
Force circulating pump	2	150	1	150	146	81.7	4	8000	94.0%	95.8%	3.3	26,122	13,583	58,500	4.3
Secondary salt extracting pump	1	30	1	30	56	31.3	5	8000	92.2%	93.5%	0.5	3,779	1,965	5,850	3.0
Cooling tower of ventilation	1	88	1	88	112	62.7	4	8000	92.7%	94.7%	1.4	11,420	5,938	17,160	2.9
big water feed pump	1	185	1	185	250	139.9	7	8000	94.2%	95.8%	2.5	19,837	10,315	36,075	3.5
Water injection pump	1	15	1	15	28	15.7	7	8000	88.5%	91.8%	0.6	5,090	2,647	2,925	1.1
Blower for cooling tower	1	33	1	33	60	33.6	7	8000	92.2%	93.5%	0.5	4,049	2,106	6,435	3.1
Oil pump for hydro-extractor	3	66	2	22	40	22.4	6	8000	91.5%	93.2%	1.3	10,706	5,567	12,870	2.3
Hydro-extractor	3	165	2	55	90	50.3	8	8000	92.6%	94.5%	3.3	26,237	13,643	32,175	2.4

Equipment	Quan. (1)	Installed KW (2)	Number of Motors in Operation (3)	Rated KW (4)	Actual Current Amps (5)	Actual KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Existing Efficiency % (9)	Proposed Efficiency % (10)	Savings KW (11)	Savings KWh (12)	Savings rmb (13)	Cost rmb (14)	Simple Payback (yrs) (15)
Chloral															
cooler water tower	2	22	2	11	20	11.2	11	8000	87.0%	90.3%	0.9	7,520	3,910	4,290	1.1
Clarified water pump	2	44	1	22	40	22.4	10	8000	91.5%	93.2%	0.9	7,137	3,711	8,580	2.3
Centrifugal water pump	2	44	1	22	40	22.4	3	8000	91.5%	93.2%	0.9	7,137	3,711	8,580	2.3
Centrifugal pump	2	60	1	30	56	31.3	3	8000	92.2%	93.5%	0.9	7,559	3,931	11,700	3.0
Chloroethylene															
Freezer	8	2000	4	250	310	173.4	4	8000	94.4%	95.8%	21.5	171,824	89,348	390,000	4.4
Freezer	6	792	2	132	200	111.9	4	8000	94.0%	95.8%	13.4	107,350	55,822	154,440	2.8
Thickened slurry pump	2	180	1	90	168	94.0	3	8000	93.5%	95.0%	3.2	25,394	13,205	35,100	2.7
Pulverizer	4	148	3	37	70	39.2	3	5400	92.2%	93.5%	2.4	12,756	6,633	28,860	4.4
Crude slurry pump	2	60	1	30	56	31.3	3	8000	92.2%	93.5%	0.9	7,559	3,931	11,700	3.0
Dilute slurry pump	2	150	1	75	140	78.3	3	8000	92.7%	94.7%	3.6	28,550	14,846	29,250	2.0
Circulating pump for cooling water	1	75	1	75	140	78.3	3	8000	92.7%	94.7%	1.8	14,275	7,423	14,625	2.0
High pressure water pump	1	18.5	1	18.5	30	16.8	3	8000	91.0%	93.0%	0.4	3,173	1,650	3,608	2.2
Centrifugal blower	2	15	2	15	14	7.8	2	5940	88.5%	91.8%	0.6	3,779	1,965	5,850	3.0
Ammonia evaporating condenser	8	88	5	11	20	11.2	4	8000	87.0%	90.3%	3.8	30,079	15,641	17,160	1.1
Cooling water circulating pump	3	45	1	15	14	7.8	3	8000	88.5%	91.8%	1.0	7,635	3,970	8,775	2.2
Delivery pump for clarified liquid	2	37	1	18.5	30	16.8	3	8000	91.0%	93.0%	0.8	6,346	3,300	7,215	2.2
Flushing pump	2	30	1	15	14	7.8	3	8000	88.5%	91.8%	0.6	5,090	2,647	5,850	2.2
Hot water pump	2	110	1	55	100	55.9	4	8000	92.6%	94.5%	2.4	19,435	10,106	21,450	2.1
Water ring pump	3	225	2	75	140	78.3	4	8000	92.7%	94.7%	5.4	42,824	22,269	43,875	2.0
Air compressor	2	264	1	132	200	111.9	7	8000	94.0%	95.8%	4.5	35,783	18,607	51,480	2.8
Air compressor	1	75	1	75	160	89.5	7	8000	92.7%	94.7%	2.0	16,314	8,483	14,625	1.7

Equipment	Quan. (1)	Installed KW (2)	Number of Motors in Operation (3)	Rated KW (4)	Actual Current Amps (5)	Actual KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Existing Efficiency % (9)	Proposed Efficiency % (10)	Savings KW (11)	Savings KWh (12)	Savings rmb (13)	Cost rmb (14)	Simple Payback (yrs) (15)
Cooling pump for filtered water	1	15	1	15	14	7.8	4	8000	88.5%	91.8%	0.3	2,545	1,323	2,925	2.2
0 Degree saline water pump	6	330	3	55	90	50.3	4	8000	92.6%	94.5%	6.6	52,474	27,287	64,350	2.4
-35 Degree saline water pump	2	110	1	55	60	33.6	4	8000	92.6%	94.5%	1.5	11,661	6,064	21,450	3.5
Makeup pump for saline water	1	15	1	15	14	7.8	4	8000	88.5%	91.8%	0.3	2,545	1,323	2,925	2.2
Cleaning pump	3	45	2	15	14	7.8	3	8000	88.5%	91.8%	1.0	7,635	3,970	8,775	2.2
Alkali pump	3	55.5	2	18.5	35	19.6	3	8000	91.0%	93.0%	1.4	11,105	5,775	10,823	1.9
Centrifugal double suction pump	2	110		55	90	50.3	3	8000	92.6%	94.5%	2.2	17,491	9,096	21,450	2.4
Hot water pump	4	220	2	55	90	50.3	3	8000	92.6%	94.5%	4.4	34,983	18,191	42,900	2.4
Canned motor pump	4	44	4	44	80	44.8	3	8000	92.2%	93.5%	2.7	21,597	11,230	34,320	3.1
Centrifugal blower	2	22	2	22	40	22.4	3	8000	91.5%	93.2%	0.9	7,137	3,711	8,580	2.3
Chlorine Hydride															
Cooled water tower	3	33	1	11	20	11.2	3	8000	87.0%	90.3%	1.4	11,280	5,865	6,435	1.1
Water ring pump	3	270	2	90	160	89.5	3	8000	93.5%	95.0%	4.5	36,278	18,864	52,650	2.8
Cooling water tower	5	275	2	55	90	50.3	3	8000	92.6%	94.5%	5.5	43,728	22,739	53,625	2.4

Equipment	Quan. (1)	Installed KW (2)	Number of Motors in Operation (3)	Rated KW (4)	Actual Current Amps (5)	Actual KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Existing Efficiency % (9)	Proposed Efficiency % (10)	Savings KW (11)	Savings KWh (12)	Savings rmb (13)	Cost rmb (14)	Simple Payback (yrs) (15)
Dimethylester															
Cooling tower	1	5.5	1	5.5	12	6.7	4	7920	85.5%	89.5%	0.4	2,779	1,445	1,073	0.7
Injection pump	3	45	3	15	46	25.7	4	7920	88.5%	91.8%	3.1	24,836	12,915	8,775	0.7
W-300 Electric motor	3	90	3	30	45	25.2	4	7920	92.2%	93.5%	1.1	9,020	4,690	17,550	3.7
Ammonia compressor	2	360	2	180	240	134.3	21	8000	94.0%	95.8%	5.4	42,940	22,329	70,200	3.1
Ammonia compressor	8	950	5	190	260	145.5	21	8000	94.2%	95.8%	20.6	165,047	85,824	296,400	3.5
Water circulating pump	3	55	1	55	95	53.1	18	8700	92.6%	94.5%	3.5	30,118	15,661	32,175	2.1
Brine pump	6	60	2	30	45	25.2	21	8700	92.2%	93.5%	2.3	19,817	10,305	35,100	3.4
Brine pump	5	165	3	55	100	55.9	21	8700	92.6%	94.5%	6.1	52,838	27,476	53,625	2.0
Brine pump	4	74	2	37	56	31.3	21	8700	92.2%	93.5%	1.9	16,441	8,549	28,860	3.4
Phosphorus Tri-Chloride															
Magnetic pump	3	30	2	15		11.3	21	7920	88.5%	91.8%	1.4	10,857	5,646	8,775	1.6
Water pump	1	15	1	15		11.3	21	7920	88.5%	91.8%	0.5	3,619	1,882	2,925	1.6
Water washing pan	1	15	1	15		11.3	21	7920	88.5%	91.8%	0.5	3,619	1,882	2,925	1.6
Water washing pan	1	18.5	1	18.5		13.9	21	7920	91.0%	93.0%	0.3	2,597	1,350	3,608	2.7
Synthesis pan	3	198	3	66		49.5	21	7920	92.6%	94.5%	3.2	25,537	13,279	38,610	2.9
Clarified water pump	2	15	1	15		11.3	19	5280	88.5%	91.8%	0.9	4,826	2,509	5,850	2.3
Vacuum pump	10	132	6	22		16.5	19	7920	91.5%	93.2%	3.3	26,051	13,546	42,900	3.2

Equipment	Quan. (1)	Installed KW (2)	Number of Motors in Operation (3)	Rated KW (4)	Actual Current Amps (5)	Actual KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Existing Efficiency % (9)	Proposed Efficiency % (10)	Savings KW (11)	Savings KWh (12)	Savings rmb (13)	Cost rmb (14)	Simple Payback (yrs) (15)
Steam Turbine															
Condenser pump 1,2	2	44	1	22	34	19.0	2	7200	91.5%	93.2%	0.8	5,460	2,839	8,580	3.0
Injection pump 1,2	2	60	1	30	44	24.6	2	7200	92.2%	93.5%	0.7	5,345	2,780	11,700	4.2
Drainage pump 1,2	2	30	1	15	22	12.3	2	7200	88.5%	91.8%	1.0	7,199	3,743	5,850	1.6
Water Demineralizing															
Clarified water pump 1,2	2	110	1	55	74	41.4	2	7200	92.6%	94.5%	1.8	12,944	6,731	21,450	3.2
Demineralizing water pump 1～3	3	135	1	45	70	39.2	2	7200	92.3%	94.1%	2.4	17,530	9,116	26,325	2.9
TOTAL	**220**	**motors**									**211.0**	**1,677,845**	**872,479**	**2,463,923**	**2.8**
											KW	**KWh**	**rmb**	**rmb**	**years**

Notes For 7.2:

1. Quantity of motors installed for this application.
2. Rated KW of all motors installed.
3. Number of motors operating at any one time.
4. Rated KW of each of the separate motors installed.
5. Average current drawn by motors in amperage as reported by the Facility.
6. Calculated KW draw of application KW = (380 volts) x (Amps) x (Power Factor = 0.85) x (1.732) / (1,000 watts/KW).
7. Age of motor in years.
8. Annual run time of motors as reported by the facility.
9. Existing motor efficiency assuming Y-series motors.
10. Proposed motor efficiency assuming YX-series motor replacements.
11. Demand Savings KW = (# of motors) x (KW draw) x [(1/Existing eff.) - (1/Proposed eff.)].
12. Annual Energy Savings KWh = (Annual hours of operation) x (Demand Savings).
13. Annual Cost Savings RMB = (Annual energy savings) x (0.52 rmb/KWh).
14. Motor Replacement Cost RMB = (Installed KW of motors) x (170 equipment + 25 labor rmb/KW)
15. Simple Payback Years = (motor replacement cost) / (Annual cost savings).

8.3 Variable Frequency Drive Measures

Equipment	Quan. (1)	Connected Load KW (2)	Quantity of Motors in Operation (3)	Rated KW (4)	Actual Current A (5)	Actual Load KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Average Load % (9)	Base Demand KW (10)	Reduced Demand KW (11)	Energy Savings KWh (12)	Cost Savings rmb (13)	Measure Cost rmb (14)	Simple Payback years (15)
Sodium Hydroxide															
Hot water pump	2	15	1	7.5	14	7.8	17	8000	60%	7.8	2.2	45,185	23,496	15,000	0.6
Water feed pump	2	400	1	200	300	167.8	11	8000	90%	167.8	129.0	310,912	161,674	400,000	2.5
Water pump	3	55.5	1	18.5	30	16.8	12	8000	60%	16.8	4.7	96,824	50,349	55,500	1.1
Pump for cooling water	3	66	3	66	40	67.1	8	8000	60%	67.1	18.7	387,297	201,395	198,000	1.0
Pump for cooling tower	2	60	1	30	56	31.3	5	8000	90%	31.3	24.1	58,037	30,179	60,000	2.0
Cooling pump	1	45	1	45	84	47.0	8	8000	60%	47.0	13.1	271,108	140,976	45,000	0.3
Big water feed pump	1	185	1	185	250	139.9	7	8000	80%	139.9	80.1	478,392	248,764	185,000	0.7
Chloral															
Clarified water pump	2	44	1	22	40	22.4	10	8000	80%	22.4	12.8	76,543	39,802	44,000	1.1
Centrifugal water pump	2	44	1	22	40	22.4	3	8000	80%	22.4	12.8	76,543	39,802	44,000	1.1
Centrifugal pump	2	60	1	30	56	31.3	3	8000	80%	31.3	17.9	107,160	55,723	60,000	1.1
Choroethylene															
Circulating pump for cooling water	1	75	1	75	140	78.3	3	8000	80%	78.3	44.8	267,900	139,308	75,000	0.5
Centrifugal pump	13	97.5	7	7.5	14	54.8	14	8000	80%	54.8	31.4	187,530	97,515	97,500	1.0
Cooling water circulating pump	3	45	1	15	14	7.8	3	8000	80%	7.8	4.5	26,790	13,931	45,000	3.2
Hot water pump	2	110	1	55	100	55.9	4	8000	70%	55.9	22.9	264,070	137,316	110,000	0.8
0 Degree saline water pump	6	330	3	55	90	151.0	4	8000	90%	151.0	116.1	279,821	145,507	330,000	2.3
-35 Degree saline water pump	2	110	1	55	60	33.6	4	8000	90%	33.6	25.8	62,182	32,335	110,000	3.4
Centrifugal double suction pump	2	110	1	55	90	50.3	3	8000	90%	50.3	38.7	93,274	48,502	110,000	2.3
Hot water pump	2	60	1	30	28	15.7	3	8000	70%	15.7	6.4	73,940	38,449	60,000	1.6
Hot water pump	4	220	2	55	90	100.7	3	8000	70%	100.7	41.3	475,326	247,170	220,000	0.9
Cooling water tower	5	275	2	55	90	100.7	3	8000	90%	100.7	77.4	186,547	97,005	275,000	2.8

Equipment	Quan. (1)	Connected Load KW (2)	Quantity of Motors in Operation (3)	Rated KW (4)	Actual Current A (5)	Actual Load KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Average Load % (9)	Base Demand KW (10)	Reduced Demand KW (11)	Energy Savings KWh (12)	Cost Savings rmb (13)	Measure Cost rmb (14)	Simple Payback years (15)
Dimethylester															
Cooling tower	1	5.5	1	5.5	12	6.7	4	7920	60%	6.7	1.9	38,342	19,938	5,500	0.3
Water circulating pump	2	15	1	15	2.2	1.2	4	7920	60%	1.2	0.3	7,029	3,655	30,000	8.2
Water pump	3	55	1	55	90	50.3	21	3000	80%	50.3	28.8	64,583	33,583	165,000	4.9
Cooling tower	4	70	4	17.5	5.8	13.0	21	8000	60%	13.0	3.6	74,877	38,936	70,000	1.8
Cooling tower	4	30	4	7.5	5.8	13.0	21	4000	60%	13.0	3.6	37,439	19,468	30,000	1.5
Water circulating pump	3	55	1	55	95	53.1	18	8700	80%	53.1	30.4	197,696	102,802	165,000	1.6
Glyphosate															
Hot water pump	2	60	1	60	24	13.4	5	7200	70%	13.4	5.5	57,039	29,660	120,000	4.0
Cooled water pump	2	60	1	60	24	13.4	5	7200	80%	13.4	7.7	41,333	21,493	120,000	5.6
Cooling															
Cooled water tower	2	60	1	30	11	6.0	5	7200	60%	6.0	1.7	31,371	16,313	60,000	3.7
Water circulating pump	2	150	1	150	110	61.5	5	7200	80%	61.5	35.2	189,443	98,511	300,000	3.0
TOTAL	85									**1,434.6**	**843.4**	**4,564,534**	**2,373,557**	**3,604,500**	**1.5**

Notes for 7.3

1. Quantity of motors installed for this application.
2. Rated KW of all motors installed.
3. Number of motors operating at any one time.
4. Rated KW of each of the separate motors installed.
5. Average current drawn by motors in amperage as reported by the Facility.
6. Calculated KW draw of application KW = (380 volts) x (Amps) x (Power Factor = 0.85) x (1.732) / (1,000 watts/KW).
7. Age of motor in years.
8. Annual run time of motors as reported by the facility.
9. Estimated average load based on seasonal variation.
10. Calculated load in KW.
11. Average reduced demand KW = (calculated load) x (Average load Percent ^3).
12. Annual Energy Savings KWh = (Annual hours of operation) x (Calculated Demand - Average reduced Demand).
13. Annual Cost Savings RMB = (Annual energy savings) x (0.52 rmb/KWh).
14. Measure Cost RMB = (Installed KW of motors) x (1000 rmb/KW), 850 rmb for the drive, 150 rmb to install.
15. Simple Payback Years = (Total measure cost) / (Annual cost savings).

8.4 ENERGY SAVINGS ANALYSIS FOR V-BELT DRIVEN MOTORS

Equipment	Quan. (1)	Connected Load KW (2)	Number of Motors in Operation (3)	Rated KW (4)	Years in Service (5)	Annual Operating Time (Hour) (6)	Assumed Motor Efficiency % (7)	Demand Savings KW (8)	Energy Savings KWh (9)	Cost Savings rmb per year (10)	Measure Cost rmb (11)	Simple Payback years (12)
Sodium Hydroxide												
Vacuum pump	4	88	3	22	10	2640	0.932	3.5	9,331	4,852	45,496	9.4
Lifter	2	15	2	7.5	7	5280	0.903	0.8	4,378	2,276	7,755	3.4
Force circulating pump	2	150	1	150	4	8000	0.958	7.8	62,519	32,510	77,550	2.4
Hydro-extractor	3	165	2	55	8	8000	0.945	5.8	46,478	24,169	85,305	3.5
Chloroethylene												
Ammonia evaporating condenser	8	88	5	11	4	8000	0.903	3.0	24,320	12,646	45,496	3.6
Single compressor	4	528	3	396	3	8000	0.958	61.9	495,153	257,480	272,976	1.1
Dimethylester												
W-300 Electric motor	3	90	3	30	4	7920	0.935	4.8	38,050	19,786	46,530	2.4
LQ1200 Electric motor	6	222	6	37	4	7920	0.935	11.9	93,857	48,805	114,774	2.4
LQ3750 Electric motor	3	270	3	90	4	7920	0.95	14.2	112,348	58,421	139,590	2.4
Dipterex												
Pulverizer	1	7.5	1	7.5	19	1320	0.903	0.4	547	285	3,878	13.6
Vacuum pump	10	132	6	22	19	7920	0.932	7.1	55,986	29,113	68,244	2.3
Glyphosate												
FD fan	1	15	1	30	7	3600	0.935	1.6	5,765	2,998	7,755	2.6
ID fan	1	30	1	60	7	3600	0.945	3.2	11,408	5,932	15,510	2.6
Blower	2	22	2	22	4	3600	0.932	2.4	8,483	4,411	11,374	2.6
Centrifugal	5	92.5	5	37	7	3600	0.935	9.9	35,552	18,487	47,823	2.6
Conveyor	1	7.5	1	15	7	3600	0.918	0.8	2,936	1,527	3,878	2.5
Acettochlor												
Evaporating condenser	2	15	1	15	10	4800	0.918	0.8	3,915	2,036	7,755	3.8
Cooling												
Evaporating condenser	2	11	2	11	10	7200	0.903	1.2	8,755	4,553	5,687	1.2
Evaporating condenser	1	5.5	1	11	7	7200	0.903	0.6	4,378	2,276	2,844	1.2
Evaporating condenser	8	88	7	22	5	7200	0.932	8.2	59,379	30,877	45,496	1.5
TOTAL	**69**							**150.0**	**1,083,538**	**563,440**	**1,055,714**	**1.9**

Notes for 7.4:

1. Quantity of motors installed for this application.
2. Rated KW of all motors installed.
3. Number of motors operating at any one time.

4. Rated KW of each of the separate motors installed.
5. Age of motor in years.
6. Annual run time of motors as reported by the facility.
7. Motor efficiency assuming units have been up-graded to YX-series motors.
8. Demand Savings KW = (# of motors) x (rated KW) x (assume 75% Load) x ([(1/0.92)-(1/0.98)] / (motor efficiency).
9. Annual Energy Savings KWh = (Annual hours of operation) x (Demand Savings).
10. Annual Cost Savings RMB = (Annual energy savings) x (0.52 rmb/KWh).
11. Estimated measure cost in rmb.
12. Simple Payback Years = (motor replacement cost) / (Annual cost savings).

8.5 OVER-SIZED MOTOR REPLACEMENTS

Equipment	Quan. (1)	Connected Load KW (2)	Number of Motors in Operation (3)	Rating KW (4)	Actual Current A (5)	Actual Rated KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Installed Motor KW (9)	Efficiency at load % (10)	Replace KW (11)	High-e Replace Efficiency % (12)	Savings KW (13)	Savings KWh (14)	Savings rmb (15)	Cost rmb (16)	Simple Payback years (17)
Sodium Hydroxide																	
Chlorine compressor	4	440	3	330	200	111.9	7	8000	110.0	87.8%	50	94.1%	11.4	91,005	47,323	38,788	0.8
Pump for cooling water	3	66	3	66	40	22.4	8	8000	22.0	85.6%	10	90.3%	1.4	10,885	5,660	5,818	1.0
Chloroethylene																	
Single compressor	4	528	3	396	210	117.5	3	8000	132.0	89.4%	52	94.1%	8.8	70,011	36,406	40,727	1.1
Dimethylester																	
Desulfurizing kettle	6	33	6	5.5	3.5	2.0	4	7920	5.5	80.0%	3	86.3%	1.1	8,491	4,415	3,055	0.7
LQ1200 Electric motor	6	222	6	37	30	16.8	4	7920	37.0	86.3%	22	93.2%	8.6	68,418	35,577	26,182	0.7
LQ3750 Electric motor	3	270	3	90	80	44.8	4	7920	90.0	84.0%	60	94.5%	17.8	140,658	73,142	34,909	0.5
Cooling tower	4	70	4	17.5	5.8	3.2	21	8000	17.5	83.4%	4	88.3%	0.9	6,909	3,593	3,375	0.9
Phosphorous Trichloride																	
Dosing pump of phosphorus dosing tank	3	12	3	4	2	1.1	11	5940	4.0	68.0%	1	78.0%	0.6	3,759	1,955	873	0.4

Equipment	Quan.	Connected Load KW	Number of Motors in Operation	Rating KW	Actual Current A	Actual Rated KW	Years in Service	Annual Operating Time (Hour)	Installed Motor KW	Efficiency at load %	Replace KW	High-e Replace Efficiency %	Savings KW	Savings KWh	Savings rmb	Cost rmb	Simple Payback years
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Glyphosate																	
Triethylamine pump	2	11	1	11	7.2	4.0	5	7200	5.5	80.0%	3	86.3%	0.4	2,646	1,376	1,047	0.8
Pre-dealcoholization pump	1	5.5	1	11	7.2	4.0	4	7200	5.5	80.0%	3	86.3%	0.2	1,323	688	524	0.8
Water ring pump for recovery of methyl chloride	2	60	1	60	24	13.4	5	2400	30.0	87.1%	9	90.3%	0.5	1,311	682	3,491	5.1
Fine distilled triethylamine liquid pump	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Northern pump for dilute methanol	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Reflux pump for Methylal	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Pump for remaining liquid of fine distillation	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Discharge pump for synthesis	2	15	1	15	8.4	4.7	5	2400	7.5	83.4%	3	86.3%	0.2	454	236	1,222	5.2
External cooling pump for first-stage hydrolyzation	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Triethylamine recovering pump	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Triethylamine charge pump	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Charge pump for evaporation	2	11	1	11	7.2	4.0	5	3600	5.5	80.7%	3	86.3%	0.3	1,166	606	1,047	1.7
Hot water pump	2	60	1	60	24	13.4	5	7200	30.0	87.1%	9	90.3%	0.5	3,933	2,045	3,491	1.7
Cooled water pump	2	60	1	60	24	13.4	5	7200	30.0	87.1%	9	90.3%	0.5	3,933	2,045	3,491	1.7
Evaporating vacuum pump	2	44	1	44	18.5	10.3	5	7200	22.0	86.3%	7	89.5%	0.4	3,087	1,605	2,691	1.7
Charge pump for neutralized primary liquid	2	15	1	15	8.4	4.7	5	7200	7.5	83.4%	3	86.3%	0.2	1,363	709	1,222	1.7
Vacuum pump for evaporation filtering	2	44	1	44	18.5	10.3	5	2400	22.0	86.3%	7	89.5%	0.4	1,029	535	2,691	5.0
Synthesizing kettle	6	111	6	37	15	8.4	7	6000	18.5	83.4%	6	89.5%	2.1	12,344	6,419	6,545	1.0

Equipment	Quan. (1)	Connected Load KW (2)	Number of Motors in Operation (3)	Rating KW (4)	Actual Current A (5)	Actual Rated KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Installed Motor KW (9)	Efficiency at load % (10)	Replace KW (11)	High-e Replace Efficiency % (12)	Savings KW (13)	Savings KWh (14)	Savings rmb (15)	Cost rmb (16)	Simple Payback years (17)
First-stage hydrolyzation kettle	2	30	2	30	12	6.7	5	7200	15.0	83.4%	4	88.3%	0.4	3,216	1,672	1,745	1.0
Temperature holding kettle for hydrolyzation	2	11	2	11	7.2	4.0	5	7200	5.5	80.0%	3	86.3%	0.4	2,646	1,376	1,047	0.8
Second-stage pre-dealcoholization kettle	2	15	2	15	8.4	4.7	4	7200	7.5	80.0%	3	86.3%	0.4	3,087	1,605	1,222	0.8
Primary liquid neutralizing kettle	1	7.5	1	15	8.4	4.7	4	7200	7.5	80.0%	3	86.3%	0.2	1,544	803	611	0.8
Methanol neutralizing kettle	1	7.5	1	15	8.4	4.7	4	7200	7.5	80.0%	3	86.3%	0.2	1,544	803	611	0.8
Primary liquid neutralizing pump	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Gear pump for dilute methanol	2	5.5	1	11	7.2	4.0	4	7200	2.8	68.0%	1	78.0%	0.4	2,734	1,422	524	0.4
Fist-stage pre-dealcoholization kettle	2	11	2	11	7.2	4.0	4	7200	5.5	80.0%	3	86.3%	0.4	2,646	1,376	1,047	0.8
Vacuum pump for acid removing	4	88	3	44	30	16.8	5	7200	22.0	84.2%	11	90.3%	2.7	19,389	10,082	8,727	0.9
Crystallizing vacuum pump	2	15	1	15	8.4	4.7	3	7200	7.5	83.4%	3	86.3%	0.2	1,363	709	1,222	1.7
Water circulating pump	2	110	1	110	85	47.6	7	7200	55.0	92.2%	32	93.5%	0.7	5,163	2,685	12,364	4.6
Water circulating pump	1	160	1	320	225	125.9	5	7200	160.0	93.1%	84	94.7%	1.1	8,223	4,276	16,364	3.8
Dealcoholization charge pump	2	15	1	15	8.4	4.7	5	4800	7.5	83.4%	3	86.3%	0.2	909	473	1,222	2.6
Pump of dilute alcohol	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Crystallizing kettle	38	209	38	11	7.2	4.0	5	4800	5.5	80.0%	3	86.3%	7.0	33,521	17,431	19,898	1.1
Acid removing kettle	19	285	19	30	10.5	5.9	7	7200	15.0	83.4%	4	86.3%	2.2	16,189	8,418	14,509	1.7

Equipment	Quan. (1)	Connected Load KW (2)	Number of Motors in Operation (3)	Rating KW (4)	Actual Current A (5)	Actual Rated KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Installed Motor KW (9)	Efficiency at load % (10)	Replace KW (11)	High-e Replace Efficiency % (12)	Savings KW (13)	Savings KWh (14)	Savings rmb (15)	Cost rmb (16)	Simple Payback years (17)
FD fan	1	15	1	30	11	6.2	7	3600	15.0	83.4%	4	88.3%	0.2	737	383	800	2.1
ID fan	1	30	1	60	24	13.4	7	3600	30.0	84.2%	9	90.3%	0.5	1,939	1,008	1,745	1.7
Blower	2	22	2	22	12	6.7	4	3600	11.0	80.7%	4	88.3%	0.7	2,578	1,340	1,745	1.3
Centrifugal	5	92.5	5	37	15	8.4	7	3600	18.5	83.4%	6	89.5%	1.7	6,172	3,209	5,455	1.7
Conveyor	1	7.5	1	15	8.4	4.7	7	3600	7.5	80.0%	3	86.3%	0.2	772	401	611	1.5
Vacuum Pump	2	44	2	44	18.5	10.3	5	7200	22.0	85.6%	7	89.5%	0.5	3,793	1,973	2,691	1.4
Filter pump of 10% glyphosate	3	22.5	3	15	8.4	4.7	5	1500	7.5	80.0%	3	86.3%	0.6	965	502	1,833	3.7
Filter press of 41% glyphosate	1	7.5	1	15	8.4	4.7	5	2400	7.5	80.0%	3	86.3%	0.2	515	268	611	2.3
Filter press of 62% glyphosate	1	7.5	1	15	8.4	4.7	5	2400	7.5	80.0%	3	86.3%	0.2	515	268	611	2.3
Vacuum pump for mixing	1	22	1	44	18.5	10.3	5	3600	22.0	85.6%	7	89.5%	0.3	948	493	1,345	2.7
10% glyphosate mixing kettle	2	37	2	37	15	8.4	5	4800	18.5	83.4%	6	89.5%	0.7	3,292	1,712	2,182	1.3
41% glyphosate mixing kettle	4	60	4	30	11	6.2	5	4800	15.0	83.4%	4	88.3%	0.8	3,931	2,044	3,200	1.6
62% glyphosate mixing kettle	3	45	3	30	11	6.2	5	4800	15.0	83.4%	4	88.3%	0.6	2,948	1,533	2,400	1.6

Equipment	Quan. (1)	Connected Load KW (2)	Number of Motors in Operation (3)	Rating KW (4)	Actual Current A (5)	Actual Rated KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Installed Motor KW (9)	Efficiency at load % (10)	Replace KW (11)	High-e Replace Efficiency % (12)	Savings KW (13)	Savings KWh (14)	Savings rmb (15)	Cost rmb (16)	Simple Payback years (17)
Acettochlor																	
Crystallizing kettle	2	15	2	15	8.4	4.7	6	4800	7.5	80.0%	3	86.3%	0.4	2,058	1,070	1,222	1.1
Etherified water injection pump	1	7.5	1	15	8.4	4.7	8	7200	7.5	80.0%	3	86.3%	0.2	1,544	803	611	0.8
Water pump	1	7.5	1	15	8.4	4.7	8	4800	7.5	80.0%	3	86.3%	0.2	1,029	535	611	1.1
Feeding vacuum pump	1	7.5	1	15	8.4	4.7	9	4800	7.5	80.0%	3	86.3%	0.2	1,029	535	611	1.1
Discharging vacuum pump	1	7.5	1	15	8.4	4.7	9	4800	7.5	80.0%	3	86.3%	0.2	1,029	535	611	1.1
Evaporating condenser	2	15	1	15	8.4	4.7	10	4800	7.5	83.4%	3	86.3%	0.2	909	473	1,222	2.6
Acylating kettle	4	44	4	22	7.2	4.0	10	4800	11.0	80.7%	3	86.3%	0.6	3,109	1,617	2,095	1.3
Feeding vacuum pump	1	11	1	22	7.2	4.0	8	4800	11.0	80.7%	3	86.3%	0.2	777	404	524	1.3
Acylating kettle	3	33	3	22	7.2	4.0	10	4800	11.0	80.7%	3	86.3%	0.5	2,332	1,213	1,571	1.3
Condensing kettle	2	22	2	22	7.2	4.0	2	4800	11.0	80.7%	3	86.3%	0.3	1,555	808	1,047	1.3
Water ring vacuum pump	1	11	1	22	7.2	4.0	6	4800	11.0	80.7%	3	86.3%	0.2	777	404	524	1.3
Cooled water pump	2	11	1	22	7.2	4.0	8	4800	5.5	68.0%	1	78.0%	0.4	1,823	948	524	0.6
Condensing kettle	4	60	4	30	18.5	10.3	3	4800	15.0	83.4%	7	89.5%	1.7	8,120	4,222	5,382	1.3
Submerged pump	2	30	2	30	18.5	10.3	10	4800	15.0	83.4%	7	89.5%	0.8	4,060	2,111	2,691	1.3
Vacuum pump	1	15	1	30	18.5	10.3	8	4800	15.0	83.4%	7	89.5%	0.4	2,030	1,056	1,345	1.3
Desolventization injecting pump	2	30	2	30	18.5	10.3	8	7200	15.0	83.4%	7	89.5%	0.8	6,090	3,167	2,691	0.8
Condensing kettle	1	22	1	22	15	8.4	8	4800	22.0	85.6%	11	90.3%	0.5	2,449	1,274	2,182	1.7
Saline water pump	2	74	1	74	28	15.7	10	4800	37.0	85.5%	10	90.3%	1.0	4,675	2,431	4,073	1.7
Freezer	5	450	5	180	140	78.3	10	4800	90.0	91.3%	52	94.1%	6.4	30,631	15,928	50,909	3.2

Equipment	Quan. (1)	Connected Load KW (2)	Number of Motors in Operation (3)	Rating KW (4)	Actual Current A (5)	Actual Rated KW (6)	Years in Service (7)	Annual Operating Time (Hour) (8)	Installed Motor KW (9)	Efficiency at load % (10)	Replace KW (11)	High-e Replace Efficiency % (12)	Savings KW (13)	Savings KWh (14)	Savings rmb (15)	Cost rmb (16)	Simple Payback years (17)
Cooling																	
Ammonia compressor	6	540	5	180	140	78.3	10	7200	90.0	92.2%	52	94.1%	5.1	37,048	19,265	61,090	3.2
Evaporating condenser	2	11	2	11	7.2	4.0	10	7200	5.5	80.0%	3	86.3%	0.4	2,646	1,376	1,047	0.8
Saline water pump	2	74	1	74	28	15.7	10	7200	37.0	85.5%	10	90.3%	1.0	7,012	3,646	4,073	1.1
Water circulating pump	2	110	1	110	90	50.3	10	7200	55.0	92.2%	34	93.5%	0.8	5,467	2,843	13,091	4.6
Evaporating condenser	1	5.5	1	11	7.2	4.0	7	7200	5.5	80.0%	3	86.3%	0.2	1,323	688	524	0.8
Cooled water tower	2	60	1	30	10.8	6.0	5	7200	30.0	87.1%	8	90.3%	0.5	3,540	1,841	3,142	1.7
Lithium bromide hot water pump	1	37	1	74	28	15.7	7	7200	37.0	86.3%	10	90.3%	0.4	2,894	1,505	2,036	1.4
Cooling tower	1	30	1	60	24	13.4	5	7200	30.0	84.2%	9	90.3%	0.5	3,878	2,016	1,745	0.9
Ammonia compressor	8	1600	7	400	300	167.8	5	7200	200.0	93.3%	112	94.5%	9.1	65,786	34,209	174,544	5.1
Evaporating condenser	8	88	7	22	9.6	5.4	5	7200	11.0	80.7%	4	86.3%	1.7	12,437	6,467	5,585	0.9
Saline water pump	4	180	3	90	65	36.4	5	7200	45.0	87.1%	24	93.2%	5.5	39,348	20,461	18,909	0.9
Water circulating pump	2	11	1	11	7.2	4.0	5	7200	5.5	80.7%	3	86.3%	0.3	2,332	1,213	1,047	0.9
Cooled water tower	1	11	1	22	8.4	4.7	5	7200	11.0	80.7%	3	86.3%	0.2	1,360	707	611	0.9
Water circulating pump	2	150	1	150	110	61.5	5	7200	75.0	93.1%	41	93.5%	0.3	2,036	1,059	16,000	15.1
TOTAL	**263**						**6.2 (average)**						**124.4**	**848,126**	**441,026**	**680,841**	**1.5**

Notes For Table 7.5:

1. Quantity of motors installed for this application.
2. Rated KW of all motors installed.
3. Number of motors operating at any one time.
4. Sum of the rated KW values for the operating motors.
5. Average current drawn by motors in amperage as reported by the Facility.
6. Calculated KW draw of application KW = (380 volts) x (Amps) x (Power Factor = 0.85) x (1.732) / (1,000 watts/KW).
7. Age of motor in years.
8. Annual run time of motors as reported by the facility.
9. Rated KW of each installed motor.
10. Efficiency of motor at operating load.
11. Proposed rating of replacement motors.
12. Proposed motor efficiency assuming YX-series motor replacements.
13. Demand Savings KW = (Replacement motor KW) x (motor load = 0.75) x [(1/old efficiency)-(1/(new efficiency)] x(# of motors).
14. Annual Energy Savings KWh = (Annual hours of operation) x (Demand Savings).
15. Annual Cost Savings RMB = (Annual energy savings) x (0.52 rmb/KWh).
16. Motor Replacement Cost RMB = (Installed KW of motors) x (170 equipment + 25 labor rmb/KW)
15. Simple Payback Years = (motor replacement cost) / (Annual cost savings).