Louisiana State University
Industrial Training & Assessment Center

Energy, Waste, and Productivity Assistance for Industry
A U.S. Department of Energy Sponsored Program

Assessment Report

Report No.:	LS2508
Location:	Duson, LA
Principal Products:	Machined Parts
SIC Number:	3599
Visit Date:	12/04/2024

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PREFACE

The work described in this report was performed by the Louisiana State University-Industrial Training & Assessment Center (LSU-ITAC) at the Louisiana State University under contract with the Office of Manufacturing and Energy Supply Chains (MESC) of the U.S. Department of Energy. The ITAC program is managed by the Center for Advanced Energy Systems, Rutgers University, Piscataway, NJ, under contract with the U.S. Department of Energy.

The objective of the ITAC program is to identify and evaluate opportunities for energy efficiency improvements through visits to industrial facilities. The evaluation process is based on the data gathered during a one-day site visit and is thereby affected in detail and completeness by limitations on time at the site. In cases where assessment recommendations (ARs) involving engineering design and capital investment are attractive to the company, it is recommended that the services of a consulting engineering firm be engaged (when in-house expertise is not available) to do detailed engineering design and to estimate implementation costs. Comments regarding this assessment report and information about plans to implement the ARs identified are solicited.

In this assessment, all students visited the facility and provided their technical assessment through field observation, and discussions with the facility personnel, and they also participated in developing the final assessment report. For this report, Asif Faisal Chowdhury was the Student Lead who led the facility visit and report writing, Sueed Willoughby was the Safety/Equipment Lead, and Blaise Segura, Cole Lemoine and Tara Bui were the Student Engineers who followed the student lead and faculty's instruction.

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1 EXECUTIVE SUMMARY

Report No.: LS2508

1.1 General Information

SIC. No.: 3599
NAICS Code: 332710
Principal Product: Machined Parts
No. of Employees: 44
Total Facility Area: 53,544 ft^2
Operating Hours: 4,862 hrs/yr

Annual Production: 1,800,000 parts/yr
Annual Sales: $10.4 million
Value per Finished Product: $5.78/parts
Total Energy Usage: 2,217 MMBTU/yr
Total Utility Cost: $79,508/yr
No. of Assessment Recommendations: 8

1.2 Annual Energy Usages and Costs

Energy usage and the corresponding costs at the facility during the twelve-month period between September 2023 and August 2024 are summarized in Table 1-1:

Table 1-1. The Facility Energy and Material Usage Summary

Type	Usage	Cost	Unit Cost
Electrical Energy	649,680 kWh/yr (2,217 MMBTU/yr)	$66,137/yr	$0.102/kWh
Electrical Demand	2,726 kW/yr	$12,326	$4.522/kW
Propane	38 MMBTU/yr	$1,045/yr	$27.50/MMBTU
Total Utility	2,255 MMBTU/yr	$79,508 /yr	-

1.3 Carbon Footprint

Based on the facility's energy consumption and regional averages (Entergy's Climate Scenario Analysis[1] and Carbon Dioxide Emissions Coefficients[2]) for carbon dioxide emissions associated with this energy release, the plant's current carbon footprint can be calculated with the results as shown in Table 1-2:

Table 1-2. The Carbon Footprint of the Facility

Electricity	248	Tons CO_2/yr
Propane	3	Tons CO_2/yr
Total	251	Tons CO_2/yr

[1] https://www.entergy.com/userfiles/content/environment/docs/EntergyClimateScenarioAnalysis.pdf
[2] https://www.eia.gov/environment/emissions/co2_vol_mass.php

1.4 Summary of Best Practices and Assessment Recommendations

The assessment team has found four best practices and five areas for potential improvements at the facility. Detailed descriptions of the best practices are presented in Section 3 of this report. The six best practices observed are listed as follows:

- Well-insulated Windows and Building Envelopes
- Programmable Thermostats and Central Controls
- Adaptation of New Efficient Machine Replacing Multiple Older Machines
- Partial Implementation of LED Lighting
- Metal Alloy Separation for Recycling

The eight Assessments Recommendations (ARs) together represent the total cost savings of \$69,026/yr, which is 86.82% of the current total annual utility costs. The total implementation cost is estimated at \$270,589, yielding an average payback of 3.92 years. If all ARs are implemented, these measures will result in an annual reduction of 193 tons/yr in carbon dioxide emissions, which is 77.05% of current emissions. Detailed analysis and savings calculations of the ARs are provided in Section 4 of this report. The ARs are summarized as follows with their key savings information as listed in Table 1-3:

AR No. 1 – Utilize Higher Efficiency Lamps and/or Ballasts

- Utilizing higher-efficiency lamps and/or ballasts will enhance lighting system performance while reducing energy consumption. This energy efficiency measure will yield \$771 in total cost savings and incur an implementation cost of \$675. The project has a payback period of 0.88 years and will reduce CO_2 emissions by 3 tons annually, with annual energy savings of 6,806 kWh.

AR No. 2 – Install Sub-metering Equipment

- Installing sub-metering equipment will enable better monitoring and management of electrical energy consumption. This energy efficiency measure will yield \$3,313 in total cost savings and incur an implementation cost of \$3,000. The project has a payback period of 0.91 years and will reduce CO_2 emissions by 12 tons annually, with annual energy savings of 32,484 kWh.

AR No. 3 – Modify Inventory Control

- Modifying inventory control systems will streamline administrative processes and improve operational efficiency. This management improvement measure will yield \$9,000 in total administrative cost savings and incur an implementation cost of \$25,000. The project has a payback period of 2.78 years.

AR No. 4 – Replace Existing HVAC with Higher Efficiency Model

- Replacing the existing HVAC system with a higher efficiency model will optimize energy consumption and improve overall system performance. This energy efficiency measure will yield \$1,488 in total cost savings and incur an implementation cost of \$5,190. The project has a payback period of 3.49 years and will reduce CO_2 emissions by 6 tons annually, with annual energy savings of 14,586 kWh.

AR No. 5 – Use Solar Heat to Generate Electricity

- Installing a solar heat system for electricity generation will significantly reduce grid electricity consumption through renewable energy adoption. This renewable energy measure will yield $39,572 in total cost savings and incur an implementation cost of $160,992. The project has a payback period of 4.07 years and will reduce CO_2 emissions by 148 tons annually while achieving substantial annual energy savings of 387,960 kWh.

AR No. 6 – Consider Replacement of Old Motors with Energy-Efficient Ones

- Replacing old motors with energy-efficient alternatives will optimize energy consumption and improve operational performance. This energy efficiency measure will yield $2,510 in total cost savings and incur an implementation cost of $10,600. The project has a payback period of 4.22 years and will reduce CO_2 emissions by 9 tons annually, with annual energy savings of 24,612 kWh.

AR No.7 – Purchase Optimum Sized Air Compressor with More Suitable Substitutes

- Purchasing an optimally sized air compressor with more suitable substitutes will enhance energy efficiency in compressed air systems. This equipment upgrade will yield $3,709 in total cost savings and incur an implementation cost of $16,949. The project has a payback period of 4.57 years and will reduce CO_2 emissions by 14 tons annually, with annual energy savings of 36,365 kWh.

AR No. 8 – Replace Fossil Fuel Equipment with Electrical Equipment

- Replacing fossil fuel equipment with electrical alternatives will modernize operations while transitioning from propane to electrical energy sources. This equipment upgrade will yield $8,663 in total cost savings and incur an implementation cost of $48,183. The project has a payback period of 5.56 years and will reduce CO_2 emissions by 1 ton annually, with an electrical energy consumption increase of 3,744 kWh/yr offset by propane savings of 38 MMBtu/yr.

Table 1-3. The Assessment Recommendation Summary Table

AR No.	Category	Description	Electricity Savings (kWh/yr)	Energy Cost Savings ($/yr)	Demand Savings (kW/yr)	Demand Cost Savings ($/yr)	Admin Cost Savings ($/yr)	Propane Savings (mmbtu/yr)	Propane Cost Saving ($/yr)	Total Cost Savings ($/yr)	CO_2 Reduction (Tons/yr)	Impl. Cost ($)	Payback Period (yrs)
1	**Lighting**	***Utilize Higher Efficiency Lamps and/or Ballasts***	6,806	694	17	77	0	0	0	771	3	675	0.88
2	**Administrative**	***Install Sub-metering Equipment***	32,484	3,313	0	0	0	0	0	3,313	12	3,000	0.91
3	**Inventory**	**Modify Inventory Control**	0	0	0	0	9,000	0	0	9,000	0	25,000	2.78
4	**Space Conditioning**	**Replace Existing HVAC with Higher Efficiency Model**	14,586	1,488	0	0	0	0	0	1,488	6	5,190	3.49
5	**Alternative Energy use**	**Use Solar Heat to Generate Electricity**	387,960	39,572	0	0	0	0	0	39,572	148	160,992	4.07
6	**Motors**	**Consider Replacement of Old Motors with Energy-Efficient Ones**	24,612	2,510	0	0	0	0	0	2,510	9	10,600	4.22
7	**Air Compressors**	**Purchase Optimum Sized Air Compressor with More Suitable Substitutes**	36,365	3,709	0	0	0	0	0	3,709	14	16,949	4.57
8	**Fuel Switching**	***Replace Fossil Fuel Equipment with Electrical Equipment***	-3,744	-382	0	0	8,000	38	1,045	8,663	1	48,183	5.56
		TOTALS	**100,267**	**10,226**	**17**	**77**	**17,000**	**38**	**1,045**	**69,026**	**193**	**270,589**	**3.92**

2 GENERAL FACILITY BACKGROUND

2.1 Facility Description

A satellite view of the 53,544 square feet facility is shown in Figure 2-1. The facility has two major areas: a production area and an office area. The facility operates two day shifts and one night shift. The two overlapping day shifts are from 5:30 AM to 3:30 PM and 7:00 AM to 5:00 PM Monday through Friday, and a night shift from 3:30 PM to 2:00 AM Monday through Thursday totaling 4,862 hrs/yr. The total number of employees is 44. Their annual production is 1,800,000 parts per year with annual sales totaling $10.4 million. The facility's operating hours and shifts are summarized in Table 2-1.

Figure 2-1. The Satellite View of the Facility

Table 2-1. The Operating Hours and Shift Schedule

Shift Start – Shift End	Days/Week	Number of Employees
5:30 AM – 3:30 PM 7:00 AM – 5:00 PM	5	44
3:30 PM – 2:00 AM	4	

2.2 Process Description

The precision machining process follows a systematic workflow that begins with raw material preparation, where materials are carefully selected and prepared according to client specifications. The materials then move to the computerized machining phase, utilizing advanced CNC equipment including multi-axis milling and turning capabilities for precision manufacturing. Following machining, the parts undergo a thorough separation and cleaning process in their climatecontrolled facility with filtered air systems to ensure contamination-free products. The components then enter the finishing phase where critical surface requirements are addressed and any necessary assembly work is completed. Each product undergoes rigorous quality testing, which evaluates dimensional accuracy and validates specifications according to ISO standards. If the product meets all quality parameters, it moves to delivery; if not, it returns to the machining phase for adjustments. This digitally integrated process ensures the production of high-precision parts that consistently meet customer requirements, specializing in shoe-box sized components and smaller ones. The process flow is shown in Figure 2-2.

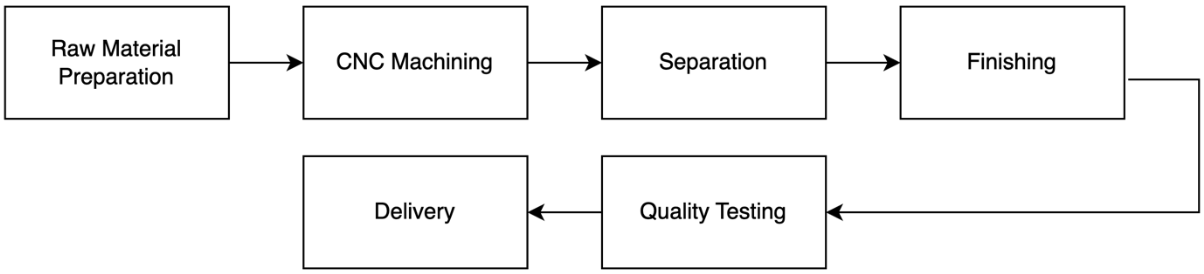

Figure 2-2. The Production Process Flowchart

2.3 Historical Energy Usage

The client provided monthly electricity costs and electricity usage of the facility for one year from September 2023 to August 2024 as shown in Figure 2-3 and Figure 2-4, respectively. The electricity rate is estimated at 10.2 cents per kWh. The following findings can be observed from the figures on electricity usage and information from the site visit:

- The electricity usage varies across the season showing a distinct pattern, with higher usage in late summer/early fall (September 2023), declining through winter to a low in January 2024, then gradually increasing again through spring and summer by August 2024
- September 2023 had both the highest usage and cost, which may indicate higher utility rates for that month.

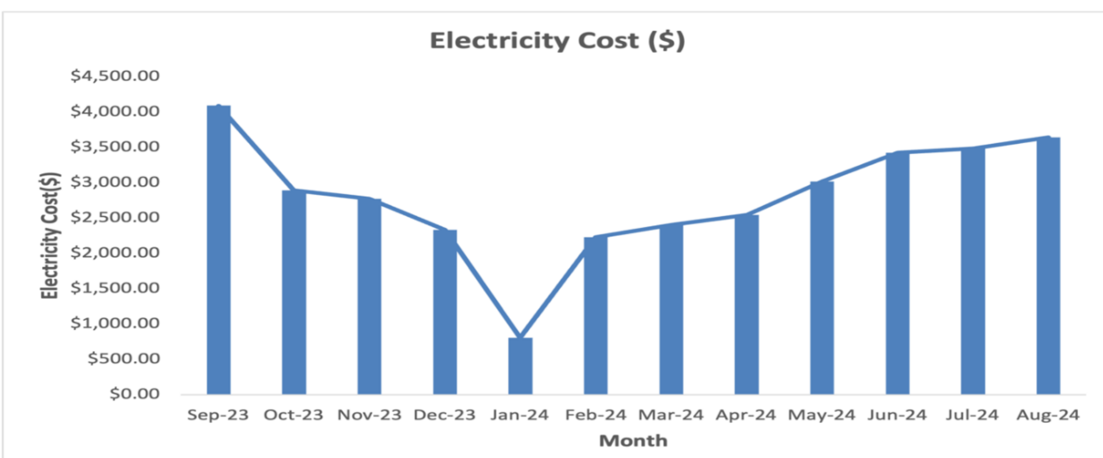

Figure 2-3. Monthly Electricity Cost

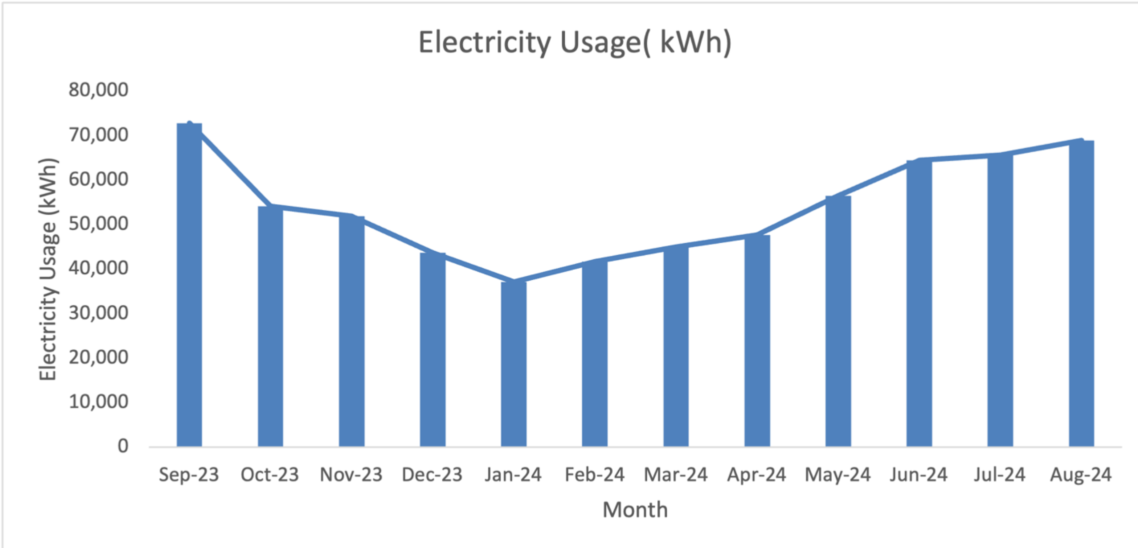

Figure 2-4. Monthly Electricity Usage

Figure 2-4 shows the following observations:

- The peak consumption occurs in September 2023 and remains high through August 2024 showing a distinct seasonal pattern where usage decreases through winter months to its lowest point in January 2024 before gradually increasing again. This seasonal variation may indicate peak production periods at the facility during late summer/early fall months when major energy-consuming equipment such as the CNC Machines may require more energy, combined with increased cooling demands during warmer months.

The facility's monthly demand costs are plotted in Figure 2-5. Figure 2-6demonstrates the monthly demand usage in kW. The demand usage follows a similar seasonal pattern to electricity usage, with peaks in September 2023 and August 2024 and a low point in February 2024 (around 175,000 kW). Based on our analysis, the demand charge is estimated to be $4.521 per kW. Notably, there was an unusual spike in demand cost in January 2024 (approximately $2,000) that doesn't correlate with the demand usage pattern, which might indicate a temporary rate increase or special charging condition for that month. Outside of the January 2024 anomaly Figure 2-5 and Figure 2-6 indicate that the demand cost and demand usage (kW) correlate with each other reasonably well.

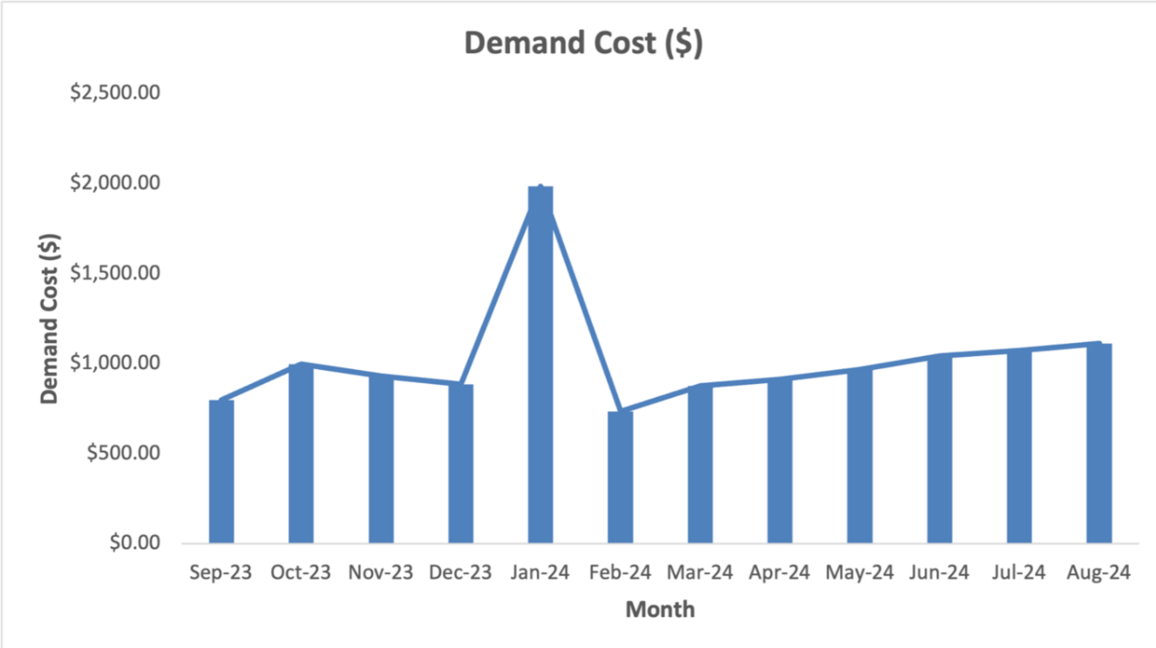

Figure 2-5. Monthly Demand Charge

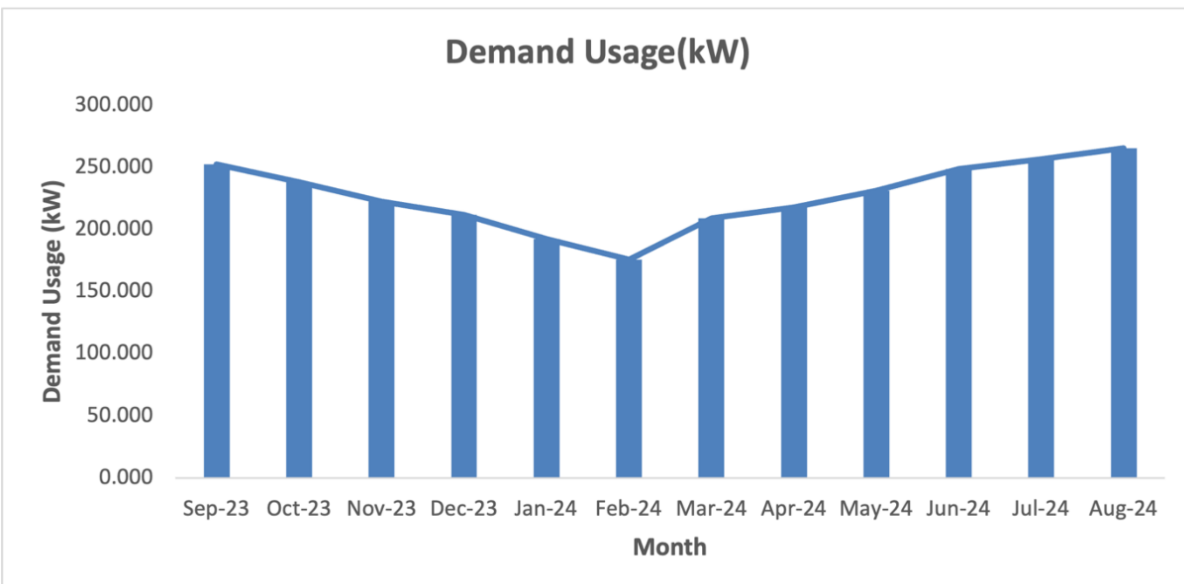

Figure 2-6. Monthly Demand Usage

2.4 Major Energy-Consuming Equipment and Devices

A list of some of the major equipment and devices is provided in Table 2-2. Figure 2-7 shows how much power is used by each piece of equipment in the facility. This figure indicates that the HVAC Units are the primary power consumers (40% of the total), followed by the CNC machines accounting for 30% of the total power.

Table 2-2. The Major Power Consuming Equipment

Energy Application	Power (hp)	Quantity	Total Power (hp)	Percentage
CNC Machine	125	1	125	30%
	55	1	55	
	53	1	53	
	49	1	49	
CNC Lathes	45	1	45	9%
	35	1	35	
Horizontal Machining Center	32	1	32	3%
CNC Turning Center	27	1	27	8%
	24	1	24	
	22	1	22	
Vertical Machining Center	23	1	23	4%
	14	1	14	
HVAC	47	8	376	40%
Air Compressor	30	2	60	6%
Total	581	21	910	100%

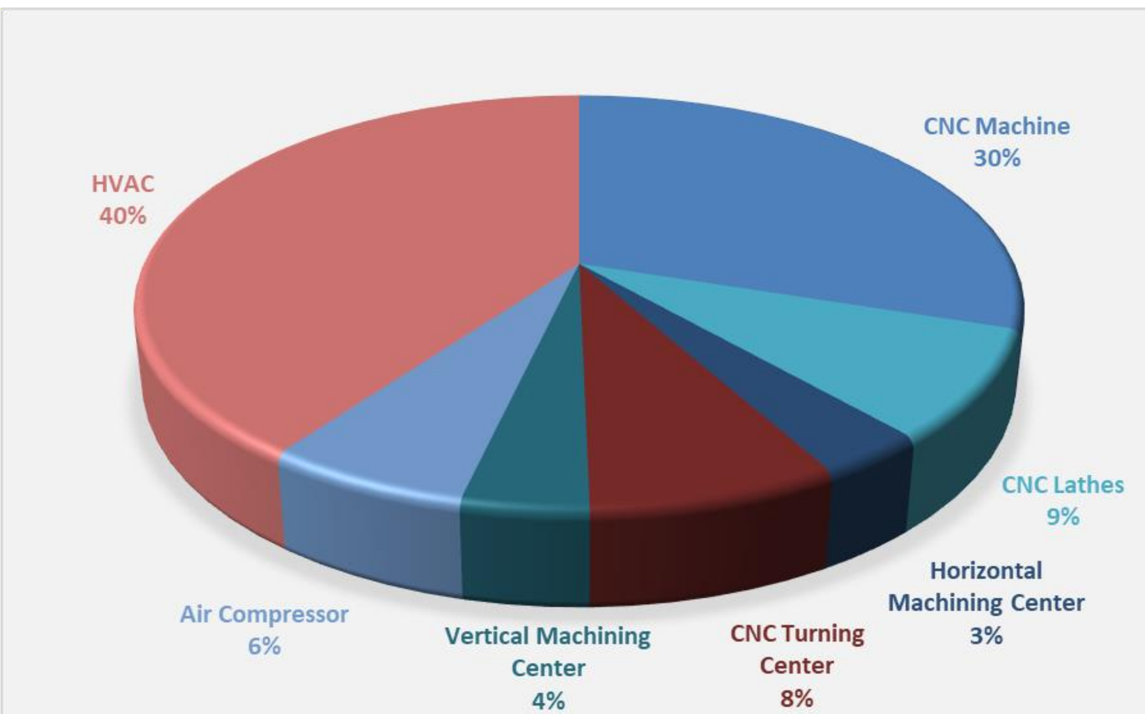

Figure 2-7. The Major Power Consumers

3 CURRENT BEST PRACTICES

During the visit and discussion with the facility managers, the LSU-ITAC team found that the facility management team currently employs a few good practices, which are briefly described below.

3.1 Well-insulated Windows and Building Envelopes

The LSU-ITAC team observed that the facility has implemented comprehensive insulation solutions for its windows and building envelope, which represents a significant best practice in energy efficiency and building performance. Well-insulated windows and building envelopes create an effective thermal barrier that minimizes heat transfer between the interior and exterior environments. This practice reduces the load on HVAC systems, resulting in lower energy consumption and operational costs. Additionally, proper insulation helps maintain consistent indoor temperatures, enhances occupant comfort, and reduces acoustic transmission from external sources. The facility's investment in high-quality insulation materials and installation demonstrates a commitment to sustainable building practices and long-term energy efficiency. (see Figure 3-1).

Figure 3-1. Well Insulated Doors in the facility.

3.2 Programmable Thermostats and Central Controls

The LSU-ITAC team observed that the facility has implemented programmable thermostats and central control systems, which represents an excellent best practice in HVAC management and energy conservation. This smart temperature control system allows for automated adjustment of facility temperatures based on occupancy schedules, operational hours, and seasonal requirements. The centralized control capability enables facility managers to monitor and adjust temperature settings across different zones from a single interface, ensuring consistent implementation of energy policies. This system optimizes energy consumption and reduces unnecessary HVAC operation during non-operational hours, leading to significant cost savings and improved equipment longevity (see Figure 3-2).

Figure 3-2. Thermostat Settings in the Facility

3.3 Adaptation of New Efficient Machine Replacing Multiple Older Machines

The LSU-ITAC team observed that the facility had integrated the advanced DMG-Mori NZX Series machine, effectively replacing multiple traditional machines in the production line. This consolidation represents a significant best practice in manufacturing efficiency and resource optimization. The DMG-Mori NZX Series demonstrates superior capabilities by performing the functions of two to three conventional machines in a single unit, streamlining operations, and reducing the overall equipment footprint. (see Figure 3-3).

Figure 3-3. DMG-Mori NZX Series Multi-Function Machine at the Facility

3.4 Partial Implementation of LED Lighting

The LSU-ITAC team observed that the facility has initiated a partial transition to LED lighting systems in selected areas of the operation. While this represents a step toward energy efficiency, there remains an opportunity for further implementation. The areas equipped with LED fixtures demonstrate the benefits of this lighting technology, including reduced energy consumption, improved illumination quality, and decreased heat emission compared to traditional lighting sources. The partial implementation serves as a proof of concept for the advantages of LED technology, showing noticeable energy savings and improved lighting conditions in the converted areas. This progressive approach to lighting upgrades allows the facility to evaluate the performance benefits while planning for complete facility-wide LED implementation, which would maximize energy efficiency and cost savings across all operations (see Figure 3-4).

Figure 3-4. LED lights in the Facility

3.5 Metal Alloy Separation for Recycling

The LSU-ITAC team observed that the facility implements a comprehensive metal segregation system for recycling different alloys as shown in Figure 3-5, which represents a best practice in materials management and environmental sustainability. This systematic approach involves carefully separating various metal alloys into designated collection areas, ensuring each type of metal maintains its purity for optimal recycling value. The practice demonstrates advanced waste management procedures that maximize the recovery value of different metal alloys while preventing cross-contamination. This segregation system not only enhances the facility's recycling efficiency but also contributes to environmental conservation by enabling high-quality metal recovery and reducing the demand for virgin materials. Additionally, this practice generates better returns on recycled materials as pure, separated alloys command higher market values than mixed metal waste.

Figure 3-5. Metal Alloy in the Facility.

4 RECOMMENDATIONS (ARs)

This section provides detailed calculations and analyses for the assessment recommendations (ARs).

4.1 AR No. 1 – Utilize Higher Efficiency Lamps and/or Ballasts

(ARC Code 2.7142)

Table 4-1. The Savings Summary for AR No. 1

Energy Savings (kWh/yr)	Energy Cost Savings ($/yr)	Demand Savings (kW/yr)	Demand Cost ($/yr)	Total Cost Savings ($/yr)	CO_2 Reduction (tons/yr)	Imp. Cost ($)	Payback Period (yrs)
6,806	694	17	77	771	3	675	0.88

Observation and Analysis

During the assessment tour, the team found that the facility used fluorescent lighting fixtures and some LED lights throughout the office areas on site. Our team observed that there would be potential for cost savings once all fluorescent lighting fixtures are replaced with energy-efficient LEDs. The current lighting fixtures are used during usual shift hours. In total, the number and power ratings of all fluorescent lighting fixtures are summarized in Table 4-2.

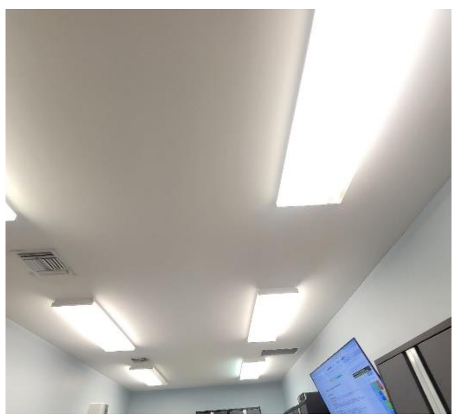

Figure 4-1. The Fluorescent Lighting at the facility.

Table 4-2. The Summary of Existing Lighting Equipment in the Facility

Type	Rated Power/ea. (W)	Quantity	Total Power (W)
4ft F32T8	32	100	3,200
Total Power (W)			3,200

Recommendation

For the maximum cost and environmental benefits, our team recommends upgrading all the facility’s lighting equipment with LED lights. The advantages of LED lights are that the LED lights can work without a ballast, have much lower-rated power, and maintain their initial lumen outputs while lasting longer than fluorescent lights. Additionally, the LED lights produce much less heat when in operation. The facility can gradually phase out the current lighting equipment every time a piece burns out and mount the new LED ones. The facility can switch out the current fluorescent lighting fixtures with the replacement of LED that is rated, as shown in Table 4-3.

Table 4-3. The Summary of Recommended Lighting Equipment in the Facility

Type	Rated Power/ea. (W)	Quantity	Total Power (W)
4ft T8 LED	18	100	1,800
Total Power (W)			1,800

Calculations

Current Energy Usage

The current fluorescent lights run typically during the day. Therefore, current energy consumption for lighting can be estimated as follows:

$$EU_C = W_c \times OH \times CF$$
$$= (3{,}200\text{ W}) \times 4{,}862\text{ hrs/yr} \times 0.001\text{ kW/W}$$
$$= 15{,}558\text{ kWh/yr},$$

where

EU_C = Current Annual Energy Usage, kWh/yr
W_c = Collective Wattage of Current Non-LED lights
OH = Operation Hours for Lights = 4,862 hrs/yr
CF = Conversion Factor (kW/W) = 0.001

Proposed Energy Usage

After the facility upgrades all fixtures to LED, the annual electricity usage can be calculated as follows:

$$EU_P = W_p \times OH \times CF$$
$$= (1{,}800\text{ W}) \times 4{,}862\text{ hrs/yr} \times 0.001\text{ kW/W}$$
$$= 8{,}752\text{ kWh/yr},$$

where

EU_P = Proposed Annual Energy Usage, kWh/yr
W_p = Collective Wattage of LED Lights
OH = Operation Hours for Lights =24hrs/day×7days/week×52weeks/yr = 8,736hrs/yr
CF = Conversion Factor (kW/W) = 0.001

Electrical Energy Savings

The total amount of electrical energy savings for this implementation can be calculated:

$$ER = EU_C - EU_P$$
$$= 15{,}558\text{ kWh/yr} - 8{,}752\text{ kWh/yr}$$
$$= 6{,}806\text{ kWh/yr},$$

where

ER = Electrical Energy Reduction, kWh/yr
EU_C = Current Electrical Energy Usage, kWh/yr
EU_P = Proposed Electrical Energy Usage, kWh/yr

Electrical Energy Cost Savings

The total electrical energy cost savings with the replacement of all the current lights with LED lights in the facility can be estimated by the following equation:

$$ECS = ER \times UR$$
$$= 6{,}806 \text{ kWh/yr} \times \$0.102/\text{kWh}$$
$$= \$694/\text{yr},$$

where

ECS = Total Electrical Energy Cost Savings, $/yr
ER = Electrical Energy Reduced, kWh/yr
UR = Average Electrical Energy Usage Rate = $0.102/kWh

Electrical Demand Savings

The total amount of electrical demand savings can be calculated using the following equation:

$$EDS = (W_{F32} - W_{T8L}) \times CF \times 12 \text{ months}$$
$$= (3{,}200 \text{ W} - 1{,}800) \times 0.001 \times 12 \text{ months}$$
$$= 17 \text{ kW/yr},$$

where

EDS = Estimated Demand Savings, kW/yr
W_{T8} = Collective Wattage of 4ft F32T8 Fluorescent Tubes
W_{T8L} = Collective Wattage of 4ft T8 LED Tubes
CF = Conversion Factor (kW/W) = 0.001

Electrical Demand Cost Savings

By lowering the amount of energy, the facility uses during its peak demand period, there will be a lower demand charge. The amount of energy demand cost savings (EDCS) can be estimated using the following equation:

$$EDCS = EDS \times DR$$
$$= 17 \text{ kW/yr} \times \$4.522/\text{kW}$$
$$= \$77/\text{yr},$$

where

$EDCS$ = Estimated Demand Cost Savings, $/yr
EDS = Electrical Demand Savings, kW/yr
DR = Demand Charge = $4.522/kW

Total Cost Savings

Since there has been a demand charge on the facility, the total cost savings is the sum of electrical energy cost savings and estimated demand cost savings:

$$TCS = ECS + EDCS$$
$$= \$694/\text{yr} + \$77/\text{yr}$$
$$= \$771/\text{yr},$$

where

TCS = Total Cost Savings, $/yr
ECS = Total Electrical Energy Cost Savings, $/yr
$EDCS$ = Estimated Demand Cost Savings, $/yr

Carbon Dioxide Reduction

Due to the reduced electrical usage, there will also be lower carbon dioxide emissions from the electrical power generation. These reductions can be calculated using:

$$CO_2 = ER \times K_1 \times K_2$$

$= 6{,}806 \text{ kWh/yr} \times (0.763 \text{ lb } CO_2 / \text{kWh}) \times 1 \text{ Ton}/2{,}000\text{lbs}$
$= 3 \text{ Tons/yr},$

where

CO_2 = Amount of Carbon Dioxide Reduced, Tons/yr
ER = Electrical Energy Reduction, kWh/yr
K_1 = Amount of CO_2 Produced per kWh, 0.763 lb CO_2/kWh
K_2 = Conversion Factor = 1 Ton/2,000 lbs

Implementation Cost

Implementation will involve the labor cost required to replace the lighting fixtures, along with the material cost of the LED lighting equipment. It is assumed that the labor cost is $25/hour, with the time needed for the replacement to be 0.2 hours per fixture for LED tubes[3] .The LED lighting costs, $5/tubes for 4ft F32 replacement.

Figure 4-2. Recommended LED Lighting Types

Also, Entergy has a rebate program[4] available in LED lighting fixture retrofit. According to the prescriptive incentive rates requirement, the facility qualifies as a large commercial entity since its monthly peak demand are more than 100 kW. The total implementation cost can be estimated by:

$IC = (N_{4ftT5} \times (UC_{4ftT5} - I_{4ftT5})) + (LR \times (LT \times N_{4ftT5}))$

$= (100 \times (\$9/\text{tube} - \$4/\text{tube}) + (\$25/\text{hour} \times (0.2 \text{ hours/fixture} \times 34 \text{ fixtures}))$
$= \$500 \text{ (material)} + \$175 \text{ (labor)}$
$= \$675$

where

IC = Implementation Cost, $

[3] https://www.youtube.com/watch?v=Zjw2UXVJaS0

[4] https://cdn.entergy-louisiana.com/userfiles/content/energy_efficiency/docs/Commercial-CI-Incentives.pdf?_gl=1*1mkb2of*_ga*ODEzMDkyMTEwLjE2NzQ5MjgxNTE.*_ga_8YKL3FLBBC*MTY3NTYwNzE0OC42LjEuMTY3NTYwODQ4OC4wLjAuMA..*_ga_HK6YSZ6LT0*MTY3NTYwNzE0OC42LjEuMTY3NTYwODQ4OC4wLjAuMA..*_ga_2KJW590NWN*MTY3NTYwNzE0OC42LjEuMTY3NTYwODQ4OC4wLjAuMA..&_ga=2.69482192.1311610344.1675607149-813092110.1674928151

N_{4ftT8} = Number of 4ft T8 LED Tubes Needed
UC_{4ftT8} = Cost per 4ft T8 LED Tube, \$/tube
I_{4ftT8} = Incentive Rate for Replacing 4ft T8 Tube, \$/tube
LR = Labor Rate, \$25/hour
LT = Labor Time per 4ftT5 Fixture Replacement, 0.2hour/fixture

The incentive cannot be greater than \$25,000. The implementation cost is summarized in Table 4-4.

Table 4-4. The Implementation Cost Summary for AR No. 1

Item	**Quantity**	**Unit Cost**	**Incentives**	**Cost ($)**
4ft T8 LED Tube[5,6]	100	$9/tube	$4/tube	500
Labor	(0.2 hours/fixture for 34 fixtures 4ft T8 LED) = 7 hrs.	$25/hr	-	175
Total Implementation Cost				675

Payback Period

PP = IC/TCS
= \$675/(\$771/yr)
= 0.88 yrs,

where

PP = Payback Period, yrs
IC = Implementation Cost, \$
TCS = Total Cost Savings, \$

[5] https://www.uline.com/Product/Detail/S-24773/Light-Bulbs/Sylvania-Type-A-Glass-LED-Tubes-48-T8-Cool-White-9-Watt?pricode=WB4846&utm_source=Bing&utm_medium=pla&utm_term=S-24773&utm_campaign=Facilities%2BMaintenance&utm_source=Bing&utm_medium=pla&utm_term=S-24773&utm_campaign=Facilities%2BMaintenance&msclkid=2041e0d3ec461c23a4d586b54c2f39b4

[6] https://www.superiorlighting.com/led-t8-universal-retrofit-bulb-4-foot-13-watt-1800-lumens-4000k-cool-white-electronic-t8-ballast-compatible-bypass-ballast/?msclkid=48255a886ab113b1c4c93ceecad8cfe6&utm_source=bing&utm_medium=cpc&utm_campaign=BPA%20-%20Items%20-%20Clearance&utm_term=4586131724760566&utm_content=BPA%20Item%20-%20Clearance

4.2 AR No. 2 – Install Sub-metering Equipment

(ARC Code 2.8117)

Table 4-5. Savings Summary for AR No. 2

Electrical Energy Savings (kWh/yr)	Electrical Energy Cost Savings ($/yr)	Total Cost Savings ($/yr)	CO_2 Reduction (Tons/yr)	Imp. Cost ($)	Payback Period (yrs)
32,484	3,313	3,313	12	3,000	0.91

Observation and Analysis

The facility is a digital machining center with multiple CNC machines and automated manufacturing equipment, each with varying power requirements and usage patterns. It will be beneficial to install sub-meters in different areas of the facility to measure energy usage, pinpoint energy waste, track energy performance, and identify opportunities for improvement. The team recommends installing sub-meters for the major energy consumers. Sub-metering by itself does not reduce energy consumption, but it provides adequate information that can initiate management and practical solutions that will result in energy reduction (Expected energy savings on submetering are shown in Figure 4-3.

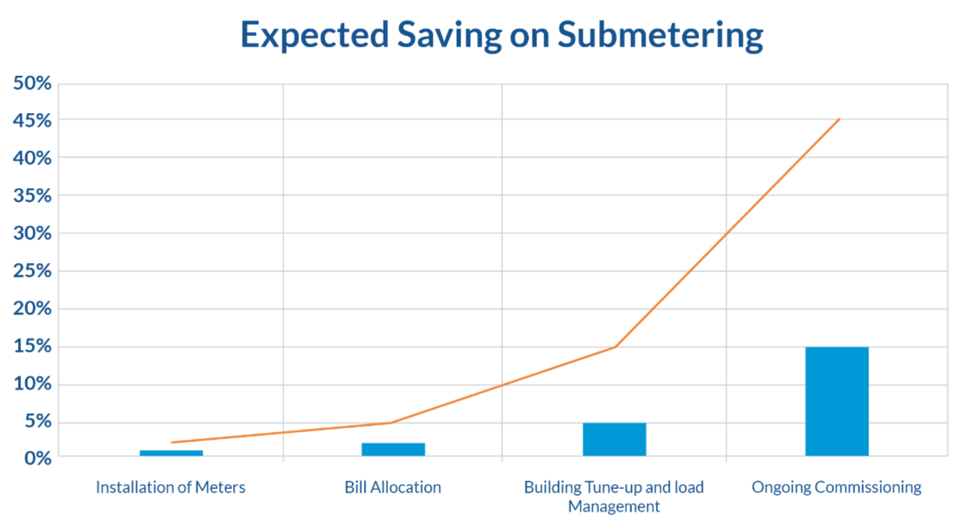

Figure 4-3. Expected Savings on Submetering[7].

Recommendation

LSU-ITAC recommends the installation of submetering systems at the facility. This will allow the facility to pinpoint areas of energy waste or inefficiency, and continuous tracking of energy performance over time. Submetering allows for the accurate allocation of energy costs to specific processes, and departments. This incentivizes energy conservation efforts as each area or department is accountable for its energy consumption and cost.

[7] https://hanatech.ca/news/hanatech-sub-metering-solution/

Calculations

The estimated savings from installing submeters will vary depending on the findings after the implementation. However, it has been shown that the installation of meters can yield up to about a 2% reduction in usage, and with a potential to achieve more than 15% savings with a continuous commissioning program[8,9]. We conservatively estimate a 5% reduction in electrical energy usage.

Electrical Energy Savings

The total annual energy savings from installing submeters on electrical energy consumers are estimated below:

ER = 0.5% × AEc
= 0.05 × 649,680 kWh/yr
= 32,484 kWh/yr,

where,

ER = Electricity Consumption Reduction
AEc = Annual Electrical Energy Consumption, kWh/yr

Electrical Cost Savings

Using the average electricity usage rate for the facility, we can calculate the total annual electrical energy cost savings as follows:

ECS = ER × UR
= 32,484 kWh/yr × $0.102/kWh
= $3,313/yr,

where,

ECS = Electrical Cost Savings, $/yr
ER = Electricity Consumption Reduction, kWh/yr
UR = Average Electrical Energy Usage Rate = $0.102 kWh

Total Cost Savings

In this case, the total cost saving is the sum of the natural gas cost savings and electrical cost savings:

TCS = ECS
= $3,313/yr,

where

TCS = Total Cost Savings
ECS = Electrical Cost Savings, $/yr

Carbon Dioxide Reduction

Due to the reduced electrical usage, there will also be lower carbon dioxide emissions from the electrical power generation. These reductions can be calculated using:

---

8 https://www.gsa.gov/system/files/Submetering_Business_Case_How_to_calculate_cost-effective_solutions_in_the_building_context.pdf

9 https://controltrends.org/hvac-smart-building-controls/controltrends-news/other/business-ideas/09/unlock-sub-metering-cost-savings-in-commercial-properties/#:~:text=Sub%20metering%20allows%20commercial%20properties%20to%20reduce%20energy,Submetering%20promotes%20transparency%20and%20accountability%20in%20utility%20billing.

CO_2 = ER × K_1 × K_2
= 32,484 kWh/yr × (0.763 lb CO_2 / kWh) × 1 Ton/2,000lbs
= 12 Tons/yr,

where

CO_2 = Amount of Carbon Dioxide Reduced, Tons/yr
ER = Electrical Energy Reduction, kWh/yr
K_1 = Amount of CO_2 Produced per kWh, 0.763 lb CO_2/kWh
K_2 = Conversion Factor = 1 Ton/2,000 lbs

Implementation Cost

The cost of implementing this recommendation includes the cost of the submeters and the cost of the installation. We recommend having submeters for four high-power machines, five medium-power machines comprising, for the HVAC system covering all air conditioning units, and for the facility infrastructure including general lighting and auxiliaries It is estimated that one submeter costs $250 and the cost of installation is about $500 per unit[10]. The implementation cost is shown below:

Table 4-6. The Implementation Cost Summary for AR No. 2

Item	Quantity	Unit Cost	Cost ($)
Submeter	4	$250	1,000
Labor Cost	4	$500	2,000
Total Implementation Cost			3,000

Payback Period

PP = IC / TCS
= $3,000/($3,313//yr)
=0.91yrs,

where

PP = Payback Period
IC = Implementation Cost, $
TCS = Total Cost Savings, $/yr

[10] https://howmuchly.com/cost-to-install-a-sub-meter

4.3 AR No. 3 – Modify Inventory Control

(ARC Code 4.322)

Table 4-7. The Savings Summary for AR No. 3

Energy Savings (kWh/yr)	Energy Cost Savings ($/yr)	Admin Cost Savings ($/yr)	Total Cost Savings ($/yr)	CO_2 Reduction (Tons/yr)	Imp. Cost ($)	Payback Period (yr)
-	-	9,000	9,000	-	25,000	2.78

Observation and Analysis

During the assessment, an evaluation of the facility's inventory management system revealed a reliance on an existing ERP system that primarily tracks inventory but lacks functionality for job cost accounting, comprehensive raw material flow tracking, and tool lifespan monitoring. The implementation of an advanced inventory management system integrating job cost accounting, tool lifespan tracking, and compatibility with SolidWorks and GibbsCAM is recommended. This system would enable real-time monitoring of raw materials from receipt to finished product, proactive maintenance of tools based on usage patterns, and more precise cost allocation for each job. By introducing such a system (see Figure 4-4), the facility can optimize inventory management, improve operational efficiency, and enhance overall productivity.

Figure 4-4. Inventory Management System[11]

Recommendation

We recommend implementing an advanced inventory management system[12,13,14] that tailored to the facility's unique needs. This system should include features such as job cost accounting, raw material flow tracking, and tool lifespan monitoring. Integration with existing design software like

[11] https://www.indiamart.com/proddetail/inventory-management-system-2850403321548.html
[12] https://www.inflowinventory.com/software-pricing-inflow-manufacturing
[13] https://www.odoo.com/app/inventory-features
[14] https://www.fishbowlinventory.com/

SolidWorks and GibbsCAM would ensure seamless communication between inventory and production planning. Furthermore, the system should automate inventory tracking, optimize reorder points, and provide real-time data on tool usage and wear. This approach would minimize tool failures, enhance workflow efficiency, and reduce manual errors in cost and inventory management. By adopting such a solution, the facility can significantly enhance operational efficiency, reduce waste, and improve productivity.

Calculations

The cost savings for this recommendation can be realized from the reduced hours attributed to repeated correction of inventory entries and reduced administrative work as more automated process is involved. Manual inventory management tasks consume a significant amount of time, with a single team member spending approximately 16 hours weekly (i.e., 3.2 hrs/day) on tasks that can be automated to increase efficiency and accuracy [15]. For our calculations, we conservatively estimate 1.5 hr/day in administrative savings attributable to the modification of the inventory control.

Administrative Savings

The time saved from reduced manual entries and repeated work is estimated below:

$$\begin{aligned} ACS &= D_s \times D_w \times W_y \times HR \\ &= 1.5\ \text{hr/day} \times 5\ \text{days/week} \times 52\ \text{weeks/yr} \times \$25/\text{hr} \\ &= \$9{,}000/\text{yr} \end{aligned}$$

Where,

ACS = Administrative Cost Savings
D_s = Hourly Savings from Modified Inventory Control
D_w = Days of Operation per Week
W_y = Weeks of Operation per Year
HR = Hour Rate at the facility.

Total Cost Saving of the facility calculated by;

Here, the total cost savings is equal to the administrative cost savings

$$\begin{aligned} TCS &= ACS \\ &= \$9{,}000/\text{yr} \end{aligned}$$

Where,

TCS = Total Cost Savings, $
ACS = Administrative Cost Savings,

Implementation Cost

The implementation cost of the advanced inventory management system will include the cost of initial setup and purchase of the software. The implementation cost will depend on the level of customization that the facility wishes to implement. For our calculations, we have the initial setup to be $8,000 and the licensing for the software to be $17,000. Hence, the total implementation cost is $25,000.

[15] https://www.altsourcesoftware.com/articles/save-40-hrs-with-5-inventory-management-tricks

IC = \$25,000

Payback Period

PP = IC/TCS
= \$25,000 / (\$9,000/yr)
= 2.78 yrs,

where

PP = Payback Period, yrs
IC = Implementation Cost, \$
TCS = Total Cost Savings, \$/yr

4.4 AR No. 4– Replace Existing HVAC with Higher Efficiency Model

ARC Code 2.7232)

Table 4-8. The Savings Summary for Additional AR No. 4

Energy Savings (kWh/yr)	Energy Cost Savings ($/yr)	Total Cost Savings ($/yr)	CO2 Reduction (Tons/yr)	Imp. Cost ($)	Payback Period (yr)
14,586	1,488	1,488	6	5,190	3.49

Observation and Analysis

During the assessment tour, the LSU-ITAC team found that the facility uses old HVAC units (see Figure 4-5) for space conditioning. The HVAC units are more than 15 years old and are less efficient than the existing HVAC units in the market. The summary of the old HVAC units' specifications is listed in Table 4-9. We obtained the energy efficiency rating (EER) from the nameplates of the units[16], which conform with ASHRAE Building Efficiency Standards[17]. Our team observed that there would be potential for cost savings once all the old HVAC units are replaced with higher-efficiency models.

Figure 4-5. HVAC Units at the Facility.

Table 4-9. The Summary of Old HVAC Units in the Facility

HVAC Unit Tonnage	Qty	Total Tonnage	EER	kW/ton (1 kW/ton = 12/EER)
10-ton	3	30-ton	11.0	1.1

Recommendation

LSU-ITAC recommends replacing the existing old HVAC units with more efficient HVAC units. This recommendation will result in reduced energy and maintenance costs. The summary of specifications of the recommended HVAC units is given in Table 4-10.

16 https://www.carrier.com/commercial/en/ae/media/DesertMasterPKG-50TCMborchure_tcm478-51454.pdf

17 https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2007_supplement.pdf

Table 4-10. The Summary of Recommended HVAC Units in the Facility

HVAC Unit Tonnage	Qty	Total Tonnage	EER[18]	kW/ton (1 kW/ton = 12/EER)
10-ton	3	30-ton	12.0	1.0

Calculations

Current Energy Usage

The amount of current annual energy usage can be calculated using the following equation:

$$EU_C = (RC \times \eta) \times CH$$
$$= (30\text{-ton} \times 1.1 \text{ kW/ton}) \times 4{,}862 \text{ hrs/yr}$$
$$= 160{,}446 \text{ kWh/yr},$$

where

EU_C = Current Annual Energy Usage, kWh/yr
η = Energy Efficiency of HVAC Units, kW/ton
RC = Total Rated Capacity of HVAC units, tons
CH = HVAC Units' Cooling Hours, hrs/yr

Proposed Energy Usage

After the facility installs the higher-efficiency HVAC units, the annual electricity usage can be calculated as follows:

$$EU_P = (RCp \times \eta_{P1}) \times CH$$
$$= (30\text{-ton} \times 1.0 \text{ kW/ton}) \times 4{,}862 \text{ hrs/yr}$$
$$= 145{,}860 \text{ kWh/yr},$$

where

EU_P = Proposed Annual Energy Usage, kWh/yr
RC = Total Rated Capacity of the Proposed HVAC units, tons
η_{P1} = Energy Efficiency of Proposed HVAC Units, kW/ton
CH = HVAC Units' Cooling Hours, hrs/yr

Electrical Energy Savings

The total amount of electrical energy savings for this implementation can be calculated as:

$$ER = EU_C - EU_P$$
$$= 160{,}446 \text{ kWh/yr} - 145{,}860 \text{ kWh/yr}$$
$$= 14{,}586 \text{ kWh/yr},$$

where

ER = Energy Reduction, kWh/yr
EU_C = Total Current Annual Energy Usage, kWh/yr
EU_P = Proposed Annual Energy Usage, kWh/yr

Electrical Energy Cost Savings

The total energy cost can be calculated using:

$$ECS = ER \times UR$$

[18] https://www.carrier.com/commercial/en/us/products/packaged-outdoor/outdoor-packaged-units/48tc/

$= 14{,}586 \text{ kWh/yr} \times \$0.102\text{/kWh}$
$= \$1{,}488\text{/yr},$

where

ECS = Total Energy Cost Savings, $/yr
ER = Energy Reduction, kWh/yr
UR = Average Electrical Energy Usage Rate = $0.102/kWh

Total Cost Savings
In this case, the total cost savings are the electrical energy cost savings:

TCS = ECS
= $1,488/yr,

where

TCS = Total Cost Savings, $/yr
ECS = Total Electrical Energy Cost Savings, $/yr

Carbon Dioxide Reduction
Due to the reduced electrical usage, there will also be lower carbon dioxide emissions in the electric power generation. These reductions can be calculated using:

$CO_2 = ER \times K_1 \times K_2$
$= 14{,}586 \text{ kWh/yr} \times (0.763 \text{ lb. } CO_2 / \text{kWh}) \times 1 \text{ Ton}/2{,}000\text{lb}$
$= 6 \text{ Tons/yr},$

where

CO_2 = Amount of Carbon Dioxide Reduced, Tons CO_2/yr
ER = Electrical Energy Reduction, kWh/yr
K_1 = Amount of CO_2 Produced per kWh = 0.763 lb. CO_2/kWh
K_2 = Conversion Factor = 1 ton/2,000 lbs

Implementation Cost

Implementation will involve the labor cost to install the HVAC units and the material cost to purchase the units. Based on online quotations from vendors[19] [20] [21], a 10-ton HVAC unit would approximately cost $20,000 per unit. The facility will need three of the 10-ton units.

Also, Entergy has a rebate program[22] available for HVAC unit installation for up to $25,000 per account. According to the prescriptive incentive rates requirement, the facility qualifies as a large

19 https://www.royalgreenny.com/Haier-MVHQ120ME2CA-MRV-5H-208-230V-10-Ton-VRF-Heat-Pump-Heat-Recovery-System?gQT=1
20 https://www.royalgreenny.com/Haier-MVHP120ME2CA-MRV-5-208-230V-10-Ton-VRF-Heat-Pump-System
21 https://cedarshvac.com/product/trane-10-ton-tta-208-230-vac-60-hz-3-phase-split-system-air-conditioner-single-circuit-condenser-air-handler-galvanized-steel-r-410a/?srsltid=AfmBOorrwGZm8Rdqvn60fApLtzekjba8IcdyJrrQ2qKusjcLX5I6MSPNx_8&gQT=1
22 https://cdn.entergy-louisiana.com/userfiles/ee/ELL_Commercial_TuneUp_Overview_2024.pdf?_gl=1*zdo6m7*_gcl_au*ODc5MzY5MDkxLjE3MzYxNDQyMjA.*_ga*MTk4NjgwMzMxMy4xNzM2MTQ0MjIx*_ga_2KJW590NWN*MTczNjE0NDIyMC4xLjEuMTczNjE0NDI4Ny41My4wLjA.*_ga_H0JW6TJK3Y*MTczNjE0NDIyMC4xLjEuMTczNjE0NDI4Ni4wLjAuMA..*_ga_8YKL3FLBBC*MTczNjE0NDIyMC4xLjEuMTczNjE0NDI4Ni41OS4wLjA.&_ga=2.144162354.629015086.1736144221-1986803313.1736144221

commercial entity since its monthly peak demand exceeds 100 kW. The incentive rate is $182/unit for installing a 10-ton unit. Also, the facility can benefit from the 179D Energy Efficient Commercial Buildings (EECB)Tax Deduction. The EECB provides a total deduction amount based on the square footage of the project or building, for projects in the year 2025, the amount is between $0.58 - $1.16/sqft[23] . We conservatively apply $1/sqft for our calculations. The total implementation cost can be estimated by:

$$\begin{aligned} IC &= (C_{HVAC} \times N) - (I_{entergy} \times N) - (A \times D_{EECB}) \\ &= (\$20{,}000 \times 3) - (\$182/\text{unit} \times 3 \text{ units}) - (53{,}544 \text{ sqft} \times \$1/\text{sqft}) \\ &= \$5{,}190 \end{aligned}$$

where

IC = Implementation Cost, $

C_{HVAC} = Cost per HVAC unit, $/unit

N = Total Number HVAC Units Needed

$I_{entergy}$ = Incentive Rate per Unit,

A = Area of the Facility, sqft

D_{EECB} = 179D EECB Tax Deduction per sqft,

The implementation cost is summarized in Table 4-11.

Table 4-11. The Implementation Cost Summary for AR No. 4

Item	**Quantity**	**Unit Cost**	**Cost ($)**
10-ton HVAC unit	3	$20,000/unit	60,000
Entergy Incentives[24]	3	$182/unit	-546
179D EECB	53,544 sqft	$1/sqft	-53,544
Total Capital Cost	-	-	5,190
Total Implementation Cost			5,190

Payback Period

$$\begin{aligned} PP &= IC/TCS \\ &= \$5{,}190 / (\$1{,}488/\text{yr}) \\ &= 3.49 \text{ yrs} \end{aligned}$$

where

PP = Payback Period, yrs

IC = Implementation Cost, $

TCS = Total Cost Savings, $/y

[23] https://www.energy.gov/eere/buildings/179d-energy-efficient-commercial-buildings-tax-deduction

[24] https://www.entergy-louisiana.com/energy-efficiency-program/ci/

4.5 AR No. 5 – Use Solar Heat to Generate Electricity

(ARC Code 2.9114)

Table 4-12. The Savings Summary for AR No. 5

Energy Savings (kWh/yr)	Energy Cost Savings ($/yr)	Total Cost Savings ($/yr)	CO_2 Reduction (tons/yr)	Imp. Cost ($)	Payback Period (yrs)
387,960	39,572	39,572	148	160,992	4.07

Observation and Analysis

During the assessment, the LSU-ITAC team was informed that the facility is interested in installing solar panels to generate electricity on-site. The facility currently has a parking area and almost no shade from the surroundings as shown in Figure 4-6. Also, the facility currently uses around 649,680 kWh/yr of electricity at a total cost of $78,462/yr. Installing solar panels and using electricity generated therein would cut its electricity bills, in addition to the environmental benefits.

Figure 4-6. Facility Space

Recommendation

We used the NREL solar calculator[25] to predetermine the potential capacity of the solar system that can be fitted on the empty space as shown in Figure 4-7. The largest space area has the potential for a maximum of 257 kW. According to the electricity provider's website[26], a Net Metering program is available for its customers for up to 300 kW of power generation, allowing customers to receive a credit on their bill for any extra electricity produced. Hence, the facility is interested in installing a solar panel system with a capacity of 257 kW to generate electricity from solar heat.

[25] https://pvwatts.nrel.gov/pvwatts.php
[26] https://www.entergy-louisiana.com/net_metering/

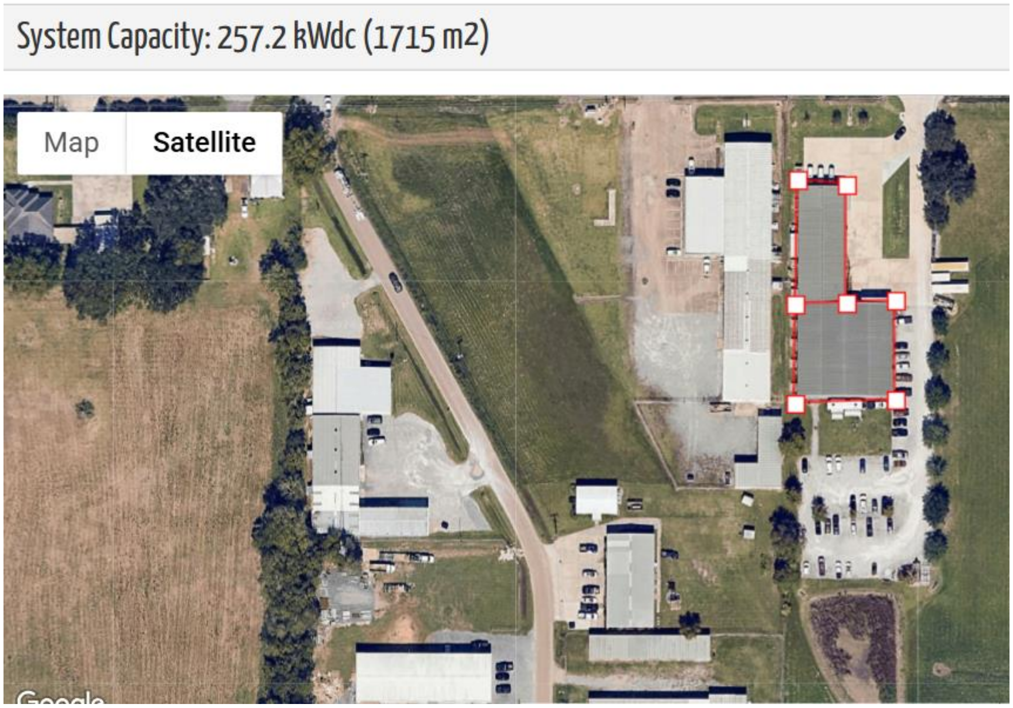

Figure 4-7. Theoretical Maximum System Capacity

Calculations

The electrical energy generated by a 257-kW photovoltaic (PV) array was simulated using the NREL solar calculator. The NREL solar calculator determines annual electrical energy output from a PV system by calculating solar radiation using the local meteorological data, factoring in the system specifics, and finally summing electrical output over all the 8,760 hours in a year. The system specifics and results are shown in Figure 4-8 and Figure 4-9 respectively.

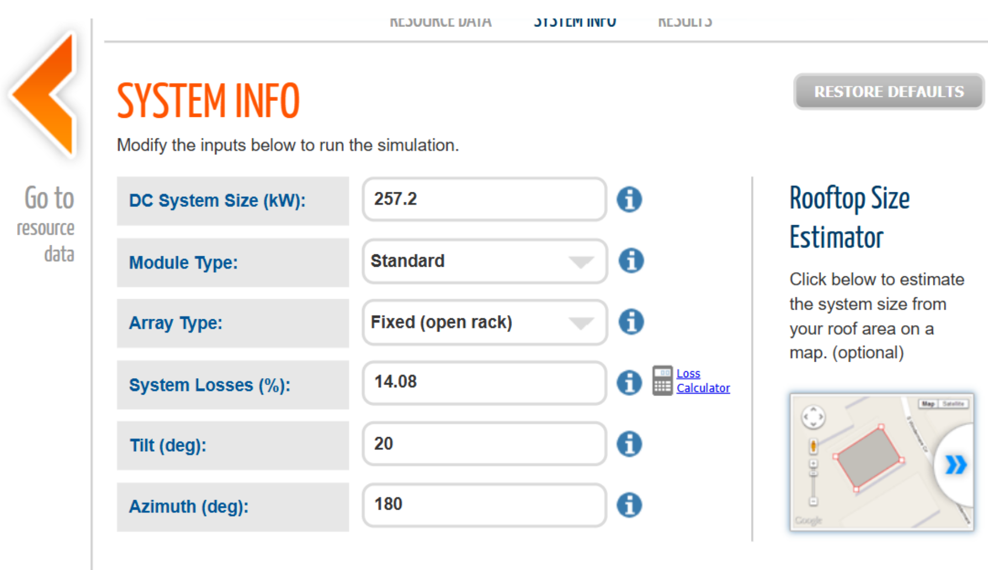

Figure 4-8. The System Specifics Inputs

RESULTS

Print Results

387,959 kWh/Year*

System output may range from 372,441 to 394,749 kWh per year near this location.

Click HERE for more information.

Month	Solar Radiation (kWh / m^2 / day)	AC Energy (kWh)
January	4.06	26,266
February	4.63	26,672
March	5.44	33,986
April	6.04	35,748
May	6.40	38,421
June	6.20	35,473
July	5.81	33,851
August	6.03	35,320
September	5.94	34,674
October	5.54	33,928
November	4.71	29,158
December	3.77	24,463
Annual	5.38	387,960

Figure 4-9. The Yearly Solar Savings Results

Electricity Energy Savings

As shown in Figure 4-12, the anticipated annual electricity savings are as follows:

ES = 387,960 kWh/yr,

where

ES = Electricity Energy Reduction, kWh

Electrical Energy Cost Savings

Using the average electrical energy usage rate for the facility, we can calculate the electrical energy cost savings as follows:

$$\begin{aligned} ECS &= ES \times UR \\ &= 387{,}960 \text{ kWh/yr} \times \$0.102\text{/kWh} \\ &= \$39{,}572\text{/yr}, \end{aligned}$$

where

ECS = Electrical Energy Cost Savings, $/yr

ES = Energy Savings, kWh/yr

UR = Average Electrical Energy Usage for the Facility = $0.102/kWh

Total Cost Savings

Since the facility does not report the demand charge, we do not have a reference for such usage. Therefore, we cannot determine how much demand can be saved by using solar panels. Hence, the total cost savings is estimated as the electrical energy cost savings:

$$\begin{aligned} TCS &= ECS \\ &= \$39{,}572\text{/yr}, \end{aligned}$$

where

TCS = Total Cost Savings, $/yr

ECS = Electrical Energy Cost Savings, \$/yr

Carbon Dioxide Reduction

Because of the resulting lower electrical usage, the plant will be responsible for lower emissions of carbon dioxide at the point of electric power generation. These reductions are calculated as follows:

CO_2 = ES × K_1 × K_2

= 387,960 kWh/yr × 0.763 lb. CO_2 / kWh × 1 Ton/2,000 lb

= 148 Tons CO_2/yr,

where

ES = Electrical Energy Savings, kWh/yr

K_1 = Conversion Factor, 0763 lb. CO_2 / kWh

K_2 = Conversion Factor, 1 Ton/2,000 lb.

Implementation Cost

The installation cost of a solar system is based on the cost per watt. In Louisiana, the installation cost for thin film solar panels is around \$0.8/W [27] based on several online quotes we received from the installers and some online resources' Louisiana does not provide any incentives for solar panel installation for commercial operations like some neighboring states but a 26 percent Federal Solar Investment Tax Credit (ITC)[28] can be claimed for systems installed in 2020-2022. The ITC then steps down to 22 percent for projects that begin in 2023 and starting in 2024, the tax credit will expire. It is better to apply for this credit program sooner. For our calculation purposes, we are considering the federal tax incentive as 22% by assuming that the facility will consider the project for the year 2023. The initial cost of the system including the ITC incentive is given in Table 4-13.

Table 4-13. The Implementation Cost Summary for AR No. 5

Item	Quantity	Unit Cost	Cost (\$)
Solar Panel Installation	257 kW	\$0.8/W	206,400
Federal Solar Investment Tax Credit[29]	22% of the Total Installation Cost	-	45,408
Total Implementation Cost			160,992

Simple Payback Period

PP = IC/ ECS

= \$160,992/(\$39,572/yr)

= 4.07 yrs,

where

PP = Payback Period, years

IC = Implementation Cost, \$

ECS = Annual Electrical Cost Savings, \$/yr

[27] https://www.forbes.com/home-improvement/solar/cost-of-solar-panels/

[28] https://www.energy.gov/eere/solar/articles/residential-and-commercial-itc-factsheets

[29] https://www.energy.gov/eere/solar/articles/residential-and-commercial-itc-factsheets

4.6 AR No. 6 – Consider Replacement of Old Motors with Energy-Efficient One *(ARC Code 2.4133)*

Table 4-14. The Savings Summary for AR No. 6

Energy Savings (kWh/yr)	Energy Cost Savings ($/yr)	Total Cost Savings ($/yr)	CO_2 Reduction (tons/yr)	Imp. Cost ($)	Payback Period (yrs)
24,612	2,510	2,510	9	10,600	4.22

Observation and Analysis

The LSU-ITAC team observed that most of the motors had been installed since the facility was quite old. Since some of these motors are extensively utilized as the facility operates 4,862 hrs/year and more energy-efficient motors are available on the market, we recommend replacing certain motors with more efficient and premium options. The team recommends replacing each of the (4) 30-HP motors on the band saw.

Recommendation

The LSU-ITAC team recommended replacing the existing old motors with energy-efficient motors. For estimating the current efficiency of motors, we used the DOE's MEASUR tool[30] to calculate the current efficiency of motors, as shown in Figure 4-10.

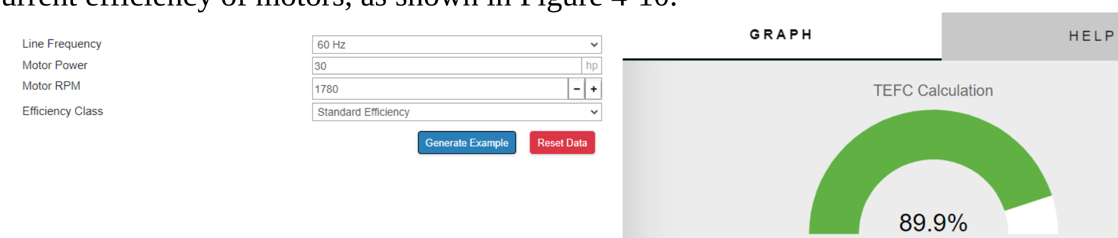

Figure 4-10. Motor Efficiency for the 30-HP Motors with Standard Efficiency at the Facility

Calculations

In the following, we used DOE's MEASUR tool to calculate the energy cost and energy savings for motors. Figure 4-11 show the result of replacing the 30HP motors on the band saw, based on the motor's operating hours and electricity cost rate, respectively.

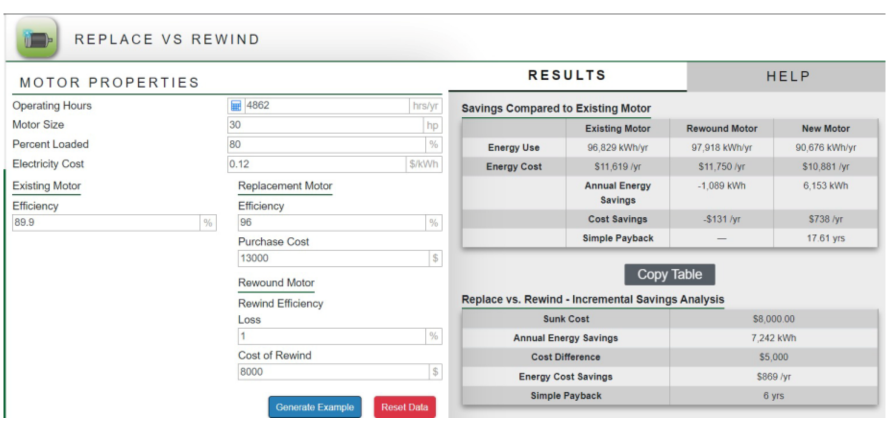

Figure 4-11. Saving Opportunities for One of the 30-HP Motors

[30] https://www.energy.gov/eere/amo/measur

Annual Energy Savings

The potential energy savings of replacing motors can be calculated based on the current and optimal energy difference (kWh) obtained from the DOE MEASUR tool, as shown below:

$$\begin{aligned} ES &= (EU_C - EU_{P)} \times N \\ &= (96{,}829 \text{ kWh/yr} - 90{,}676 \text{ kWh/yr}) \times 4 \\ &= 24{,}612 \text{ kWh/yr}, \end{aligned}$$

where

- ES = Energy Savings of 30 HP motors, kWh/yr
- EU_C = Current Energy Usage, kWh/yr
- EU_P = New Motor Energy Usage, kWh/yr
- N = The Number of current Motors that Need to be Upgraded

Then, the total energy cost savings can be calculated as follows:

$$ER = ES$$

$$ER = 24{,}612 \text{ kWh/yr}$$

where

- ER = Electrical Energy Reduction, kWh/yr
- ES = Energy Savings of 30 HP motors, kWh/yr

Electrical Energy Cost Savings

The total energy cost savings after the facility replaced the tank mixers with the efficient ones can be calculated using:

$$\begin{aligned} ECS &= ER \times UR \\ &= 24{,}612 \text{ kWh/yr} \times \$0.102/\text{kWh} \\ &= \$2{,}510/\text{yr}, \end{aligned}$$

where

- ECS = Total Energy Cost Savings, \$/yr
- ER = Electrical Energy Reduction, kWh/yr
- UR = Average Electrical Energy Usage Rate = \$0.102/kWh

Total Cost Savings

In this case, the total cost savings are the electrical energy cost savings:

$$\begin{aligned} TCS &= ECS \\ &= \$2{,}510/\text{yr} \end{aligned}$$

where

- TCS = Total Cost Savings
- ECS = Total Electrical Energy Cost Savings, \$/yr

Carbon Dioxide Reduction

Due to the reduced electrical usage, there will also be lower carbon dioxide emissions in electric power generation. These reductions can be calculated using:

$$\begin{aligned} CO_2 &= ER \times K_1 \times K_2 \\ &= 24{,}612 \text{ kWh/yr} \times (0.763 \text{ lb. } CO_2 / \text{kWh}) \times 0.0005 \text{ Ton/lb} \\ &= 9 \text{ Tons/yr}, \end{aligned}$$

where

CO_2 = Amount of Carbon Dioxide Reduced, Tons CO_2/yr
ES = Energy Savings, kWh/yr
K_1 = Amount of CO_2 Produced per kWh = 0.763 lb. CO_2/kWh
K_2 = Conversion Factor = 0.0005 Ton/lb

Implementation Cost

The implementation cost includes the capital cost to purchase the new motors and the labor cost for the removal and installation of these. Two workers for one hour will be required to remove one old motor, and two workers for one hour will be required to install a new motor (i.e., 1 hour/motor for two workers). The implementation costs for the recommendation are summarized in Table 4-15.

Table 4-15. The Implementation Cost Summary for AR No. 6

Motors	**Unit Cost ($)**	**Quantity**	**Total ($)**
30-HP Motor with the Efficiency of 96% [31,32]	$2,600	4	$10,400
Total Material Cost (4 motors)			$10,400
Labor Cost (2 workers considered for 4)	$25/worker	1 hr/motor	$200
Total Implementation Cost			$10,600

Payback Period

PP = IC / TCS
= $10,600/($2,510/yr)
= 4.22 yrs,

where

PP = Payback Period, yrs
IC = Implementation Cost, $
TCS = Total Cost Savings, $/yr

[31] https://www.precision-elec.com/shop/u30p2dc/?msclkid=f9c4b7b1692316e960c5d1bb86c85132
[32] https://www.precision-elec.com/shop/30hp1770rpm3ph60hz286tctefcf1-cecp84104t-4/?msclkid=b93686a6ae75154d0698e0ac419e0126

4.7 AR No. 7 – Purchase Optimum Sized Air Compressor with More Suitable Substitutes *(ARC Code 2.4226)*

Table 4-16. The Savings Summary for AR No. 7

Energy Savings (kWh/yr)	Energy Cost Savings ($/yr)	Total Cost Savings ($/yr)	CO_2 Reduction (Tons/yr)	Imp. Cost ($)	Payback Period (yr)
36,365	3,709	3,709	14	16,949	4.57

Observation and Analysis

During the assessment tour, the LSU-ITAC team found that the facility operates with two Air Compressor and one of the air compressors is very old and used alternatively with the new one, as shown in Figure 4-12. Upgrading this machine to a newer, and smart machine could notably reduce labor and offer maintenance and energy efficiency improvements. This change promises considerable savings and increased productivity.

Figure 4-12. The Air Compressor at the warehouse

Recommendation

According to the facility personnel, the old Air Compressor Machine needs to be replaced. Therefore, LSU-ITAC recommends that the facility replace the old Air Compressor Machine, with a new, more efficient machine. It would also likely offer improved energy efficiency, lower maintenance costs due to its newer technology, and potentially higher production output with better quality control. The initial investment in this machine could be offset by these long-term savings. The new air compressor will work in conjunction with the main air compressor, and we believe the reduction in capacity (20 HP) will not affect operations while generating cost savings. Furthermore, consolidating the process into a more advanced machine can offer additional flexibility for future operational needs or expansions. This recommendation aims to enhance the efficiency and productivity of the facility's packaging department, aligning with modern manufacturing practices and potentially providing a quick return on investment. This recommendation will result in reduced energy and maintenance costs.

Calculations

Current Energy Usage

The amount of current annual energy usage can be calculated using the following equation

$$
\begin{aligned}
EU_C &= \frac{HP}{\eta} \times C_{kW,hp} \times Hrs \times N \\
&= \frac{30}{0.968} \times 0.7459 \times 4{,}862 \times 1 \\
&= 112{,}394 \text{ kWh/yr},
\end{aligned}
$$

where

- EU_C = Current Annual Energy Usage of the Air Compressor
- HP = Compressor Horsepower = 30
- η = Efficiency of Compressor Motor[33] = 0.968
- $C_{kW,hp}$ = Conversion Constant = 0.7459 kW/hp
- L = Load Factor = 0.7
- N = Number of Air Compressor = 1
- OH = Operation Hours for Air Compressor Machine = 93.5 hrs /week×52 weeks/yr = 4,862 hrs/yr

Proposed Energy Usage

After the facility installs the higher efficiency Air Compressor, the annual electricity usage can be calculated as follows:

$$
\begin{aligned}
EU_P &= \frac{HP}{\eta} \times C_{kW,hp} \times Hrs \times N \\
&= \frac{20}{0.954} \times 0.7459 \times 4{,}862 \times 1 \\
&= 76{,}029 \text{ kWh/yr},
\end{aligned}
$$

where

- EU_P = Proposed Annual Energy Usage of the Air Compressor
- HP = Compressor Horsepower = 20
- η = Efficiency of Compressor Motor[34] = 0.954
- $C_{kW,hp}$ = Conversion Constant = 0.7459 kW/hp
- L = Load Factor = 0.7
- N = Number of Air Compressor = 1
- OH = Operation Hours for Air Compressor Machine = 93.5 hrs/week×52 weeks/yr = 4,862 hrs/yr

Electrical Energy Savings

The total amount of electrical energy savings for this implementation can be calculated as:

$$
\begin{aligned}
ER &= EU_C - EU_P \\
&= 112{,}394 \text{ kWh/yr} - 76{,}029 \text{ kWh/yr} \\
&= 36{,}365 \text{ kWh/yr},
\end{aligned}
$$

where

- ER = Energy Reduction, kWh/yr
- EU_C = Total Current Annual Energy Usage, kWh/yr
- EU_P = Proposed Annual Energy Usage, kWh/yr

[33] https://www.energy.gov/sites/prod/files/2014/04/f15/amo_motors_handbook_web.pdf
[34] https://www.energy.gov/sites/prod/files/2014/04/f15/amo_motors_handbook_web.pdf

Electrical Energy Cost Savings
The total energy cost can be calculated using:

ECS = ER × UR
= 36,365 kWh/yr × $0.102/kWh
= $3,709/yr,

where

ECS = Electrical Energy Cost Savings, $/yr
ER = Energy Reduction, kWh/yr
UR = Average Electrical Energy Usage Rate = $0.102/kWh

Total Cost Savings
In this case, the total cost savings are the electrical energy cost savings:

TCS = ECS
= $3,709/yr

where

TCS = Total Cost Savings
ECS = Total Electrical Energy Cost Savings, $/yr

Carbon Dioxide Reduction
Due to the reduced electrical usage, there will also be lower carbon dioxide emissions at the electric power generation. These reductions can be calculated using:

CO_2 = ER × K_1 × K_2
= 36,365 kWh/yr × (0.763 lb. CO_2 / kWh) × 1 Ton/2,000lb
= 14 Tons/yr,

where

CO_2 = Amount of Carbon Dioxide Reduced, Tons CO_2/yr
ER = Electrical Energy Reduction, kWh/yr
K_1 = Amount of CO_2 Produced per kWh = 0.763 lb. CO_2/kWh
K_2 = Conversion Factor = 1 ton/2,000 lbs

Implementation Cost

The implementation of this recommendation will include the labor cost to install the air compressor and the material cost to purchase the air compressor. The cost of a 20 HP air compressor is estimated to be around $11,299, and the labor cost was estimated to be 50% of the material costs. The costs are listed in Table 4-17.

Table 4-17. The Implementation Cost Summary for AR No. 7

Item	**Cost ($)**
Material (One 20 HP Air Compressor)[35]	11,299
Labor (50% of Material Costs)	5,650
Total Implementation Cost	16,949

Payback Period

PP = IC / TCS

[35] https://www.aircompressorsdirect.com/EMAX-ERV0200003-460-Air-Compressor/p14563.html

$$= \$16{,}949 / (\$3{,}709/\text{yr})$$
$$= 4.57 \text{ yrs},$$

where

PP = Payback Period, yrs
IC = Implementation Cost, \$
TCS = Total Cost Savings, \$/yr

4.8 AR No. 8 – Replace Fossil Fuel Equipment with Electrical Equipment

(ARC Code 2.1321)

Table 4-18. The Savings Summary for AR No. 8

Propane Energy Savings (MMBtu/yr)	Propane Energy Cost Savings ($/yr)	Electrical Energy Usage (kWh/yr)	Electrical Energy Cost ($/yr)	Operation Cost Savings ($/yr)	Total Cost Savings ($/yr)	CO_2 Reduction (Tons/yr)	Imp. Cost ($)	Payback Period (yr)
38	1,045	-3,744	-382	8,000	8,663	1	48,183	5.56

Observation and Analysis

The LSU-ITAC team observed that the property had 1 propane-powered forklift to move products and materials in the facility and the warehouse. We recommend converting the forklift (See Figure 4-13) to electric forklift. The forklift consumes a significant amount of energy with high operating costs for their daily usage. The team saw this as an opportunity to replace propane-powered forklifts with electric ones to reduce operation and maintenance costs on the usage of forklifts. Furthermore, electric forklifts offer significant environmental benefits by producing zero emissions during operation, contributing to cleaner air quality, and reducing the carbon footprint of industrial operations. This aligns with sustainability goals and demonstrates a commitment to environmental stewardship.

Figure 4-13. Propane-powered forklift in the facility

Recommendation

The LSU-ITAC team recommends the transition of fossil fuel equipment with electrical equipment, in this case, the replacement of propane-powered forklifts with electric alternatives. The economic advantages of electric forklifts, including lower operating costs and enhanced energy efficiency, align with the facility's commitment to fostering sustainable industrial practices with a potential for energy cost savings. Fossil fuel produces additional emissions to the environment during the usage of such equipment. It is estimated that using an electric forklift instead of propane can reduce CO_2 emissions by 20,145 lbs annually[36]. Implementing this recommendation exemplifies environmental responsibility by eliminating harmful emissions, contributing to cleaner air quality, and reducing carbon footprints.

Calculations

To calculate the savings, we have the total consumption of the propane used by the forklift annually and the rate at which propane is supplied to the facility. Propane is only utilized by the forklift in the facility. The annual consumption of the forklift is 418 Gal (38 MMBtu). The electric forklift is charged during the night and used for three days before being recharged.

Current Energy Usage

PR = CG × CF
= 418 Gal/yr × 0.091547 MMBTU/Gal
= 38 MMBtu/yr

where,

PR = Propane Energy Reduction, MMBTU/yr
CG = Propane Consumption from Utility, Gallon/yr
CF = Conversion Factor, 0.091547 MMBTU/Gal

Proposed Propane Cost Savings

PCS = PR × UR
= 38 MMBtu/yr × $27.50/MMBtu
= $1,045/yr,

where,

PCS = Propane Cost Savings, $/yr
PR = Propane Energy Reduction, MMBtu/yr
UR = Average Propane Gas Energy Usage Rate, $27.50/MMBtu

In a similar facility with electrical forklifts, when the forklift is fully charged, it can operate for three days before power runs out. The charging duration of the battery is estimated as 3 hrs. Thus, the charging hours can be calculated below:

Annual Charging Duration

Ch = Rd × Cw × Wy
= 3 hrs/charge × 5 charges/week × 52 weeks/yr
= 780 hrs/yr,

where,

Ch = Proposed Annual Charging Duration of Each Forklift, Hrs/yr
Rd = Rated Charging Duration of Battery
Cw = Number of Charges per Week

[36] https://www.conger.com/electric-forklifts-vs-propane/

The facility is interested in getting a forklift with a battery capacity of 1100 Ah[37] and a fast charger of 200 A[38]. Through this information, we can calculate the annual consumption of the proposed forklift.

Power-Rating of the Charger

$$
\begin{aligned}
Pc &= I \times V \\
&= 200\ A \times 24\ V \\
&= 4{,}800\ \text{Watts}
\end{aligned}
$$

Proposed Energy Usage

$$
\begin{aligned}
EUp &= -\ (Pc \times K_1 \times Ch \times N) \\
&= -\ (4{,}800\ W \times 0.001\ kW/W \times 780\ hrs/yr \times 1) \\
&= -\ 3{,}744\ kWh/yr,
\end{aligned}
$$

where,

EU_P = Proposed Energy Usage, kWh/yr
Pc = Power Rating of the Forklift Charger, W
K_1 = Conversion Constant, 0.0001 kW/W
Ch = Proposed Charging Duration of Each Forklift, Hrs/yr
N = Number of Electric Forklift

Proposed Energy Cost,

$$
\begin{aligned}
ECS &= EUp \times UR \\
&= -3{,}744\ kWh/yr \times \$0.102/kWh \\
&= -\$382/yr,
\end{aligned}
$$

where,

ECS = Electrical Energy Cost, $/yr
EU_P = Proposed Energy Usage, kWh/yr
UR = Utility Rate, $/yr

Operational Cost Savings

The facility has mentioned that there is a need for regular maintenance of the propane-powered forklifts. Entergy's Etech program for forklifts[39] estimated at $10,500/yr for the propane forklifts and $2,500/yr for the electric forklifts.

$$
\begin{aligned}
OCS &= N \times (OCp - OCe) \\
&= 1 \times (\$10{,}500/yr - \$2{,}500/yr), \\
&= \$8{,}000/yr
\end{aligned}
$$

where,

OCS = Operational Cost Savings, $/yr

[37] https://www.toyotaforklift.com/content/dam/tmh/marketing/en/pdf/product-spec-brochures/2022_3-Wheel%20Electric_Spec%20Sheet_Digital.pdf#page=2
[38] https://www.forklift-battery-charger.com/three-phase/24-volt-200-amp.php
[39] https://entergyetech.com/electric-forklifts/

OCp = Operational Cost for the Propane-Powered Forklifts, \$/yr
OCe = Operational Cost for the Electric-Powered Forklifts, \$/yr
N = Number of Propane-Powered Forklift to be Replaced

Total Cost Savings,
In this case, the total cost savings is the addition of the operational cost savings and the propane cost savings.

$$\begin{aligned} TCS &= PCS + OCS + ECS \\ &= \$1{,}045/yr + \$8{,}000/yr + (-\$382/yr) \\ &= \$8{,}663/yr, \end{aligned}$$

where,
TCS = Total Cost Savings, \$/yr
OCS = Operational Cost Savings, \$/yr
PCS = Propane Energy Cost Savings, \$/yr
ECS = Electrical Energy Cost, \$/yr

Carbon Dioxide Reduction
Due to reduced propane usage, there will corresponding reduction in carbon dioxide emissions. These reductions can be calculated using:

$$\begin{aligned} CO_2 &= PR \times K_1 \times K_2 + EU_p \times K_3 \times K_4 \\ &= 38 \text{ MMBtu/yr} \times (138.63 \text{ lbs of } CO_2 / \text{ MMBtu}) \times 0.0005 \text{ Tons/lbs} + (-3{,}744 \text{ kWh/yr} \times (0.763 \text{ lb. } CO_2 / \text{kWh}) \times 1 \text{ Ton/2,000lb} \\ &= 1 \text{ Tons/yr}, \end{aligned}$$

where
CO_2 = Amount of Carbon Dioxide Reduced, Tons/yr
PR = Propane Energy Reduction, MMBtu/yr
K_1 = Amount of CO_2 Produced per MMBtu of Propane, 138.63 lbs CO_2 / MMBtu[40]
K_2 = Conversion Factor = 0.0005 Tons/lbs
EU_p = Proposed Energy Usage, kWh/yr
K_1 = Amount of CO_2 Produced per kWh, 0.763 lb CO_2/kWh
K_2 = Conversion Factor = 1 Ton/2,000 lbs

Implementation Cost

The implementation cost for this recommendation is purchasing or leasing the electric forklifts with its accessories at the facility (Figure 4-14). The four-wheel electric forklifts have varying capacities and costs. The facility has solicited quotes for these electric forklifts. The options they are considering include a total cost of \$48,683 for the forklift, a battery, a charger, and accessories. They are open to an incentive of \$500/forklift purchased as provided by Entergy's Etech program[41].

[40] https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub-2024.pdf
[41] https://entergyetech.com/electric-forklifts/

Figure 4-14. Electrical Forklift

Table 4-19. The Implementation Cost Summary for AR No. 8

Item	Quantity	Unit Cost	Cost ($)
Forklift (including accessories)	1	$48,683	$48,683
Incentive	1	$500	-$500
Total Implementation Cost			$48,183

Payback Period

PP = IC/TCS
= $48,183/ ($8,663/yr)
= 5.56 yrs,

where

PP = Payback Period, yrs
IC = Implementation Cost, $
TCS = Total Cost Savings, $/yr

5 THE INDUSTRIAL CONTROL SYSTEMS CYBERSECURITY ASSESSMENT

The Industrial Control Systems (ICSs) Cybersecurity Assessment Tool developed by the U.S. Department of Energy can be used to identify cybersecurity risks in small- and medium-sized manufacturing facilities. This assessment tool is based on a questionnaire to be answered by the facility's IT personnel during the assessment, as shown in Table 5-1. This tool can be used to identify risk areas, provide cybersecurity awareness information, and potential solutions, and suggest action items based on the response selected. Due to privacy, this client declined to answer the assessment questions, but we add this tool here for the client's self-assessment later if they decide to.

Table 5-1. Industrial Control Systems Cybersecurity Assessment Details

People			
1	**Does your plant or facility provide basic cybersecurity awareness training to all employees?** *No Response*	*No Comments*	
2	**Are staff assigned and trained to take appropriate measures during a cybersecurity incident?** *No Response*	*No Comments*	
3	**Do your industrial control system (ICS) vendors provide remote support?** *No Response*	*No Comments*	
4	**What level of on-site physical security does your facility or plant enforce upon vendors?** *No Response*	*No Comments*	
5	**Do third party vendors have proper cybersecurity training?** *No Response*	*No Comments*	
6	**Do vendors utilize their own equipment, hardware, or software during site visits?** *No Response*	*No Comments*	
Process			
7	**Have you identified critical equipment in your plant or facility that would cause disruption to your operations if they were compromised?**	*No Comments*	

	No response		
8	**Does a plan exist to identify and isolate impacted assets, or shut down equipment as necessary in the event of a cybersecurity incident?** *No Response*	*No Comments*	
9	**Does your plant or facility have a cybersecurity incident response procedure?** *No Response*	*No Comments*	
10	**Does a central repository containing equipment schematics, IT infrastructure drawings, and system network layouts exist within the facility?** *No Response*	*No Comments*	
11	**Is cybersecurity considered when purchasing supplies or equipment, and is it defined in your contractual obligations with vendors?** *No Response*	*No Comments*	
12	**Does plant/facility equipment get regularly or automatically scanned for cybersecurity issues (e.g., malware, etc.)?** *No Response*	*No Comments*	
13	**Is the use of external media by staff and vendors regulated within the plant/facility and scanned for cybersecurity issues?** *No Response*	*No Comments*	
Technology			
14	**Which of the following best describes the industrial controls in your plant or facility?** *No Response*	*No Comments*	

15	**Are indicators or alerts set up on critical equipment to indicate unusual changes to operating parameters, multiple login attempts, or detect other anomalies in use?** *No Response*	*No Comments*	
16	**Does the plant or facility have any equipment that is programmable or reconfigurable by remote staff?** *No Response*	*No Comments*	
17	**Does your industrial control system (ICS) allow remote access?** *No Response*	*No Comments*	
18	**Are there processes in your plant with operating parameters that are interdependent with other processes?** *No Response*	*No Comments*	
19	**How are modifications to parameters or set-points made within your manufacturing process?** *No Response*	*No Comments*	
20	**Do the computers that run your industrial control system (ICS) allow employees or vendors to import files from external media?** *No Response*	*No Comments*	
Overall Risk: -			