

Sample Report

Facility Energy Audit

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Executive Summary

Overview

Foresight Management (Foresight) performed an energy audit and thermal imaging studies at ABC Company’s SUBSIDIARY facility in CITY, STATE to assess the potential for cost effective Energy Conservation Measures (ECMs) in support of ABC Company’s energy efficiency goals.

The facility represents 160,500 square feet with a total annual energy consumption of approximately 21,000,000 kWh of electricity and 2,100,000 CCF of natural gas per year, resulting in 34,725 tonnes of greenhouse gas (GHG) emissions. Including all energy consumption sources, ABC Company’s annual energy expenditure is about \$4.1 million per year.

The average Energy Use Intensity (EUI) in this manufacturing facility is around 463 kBtu/square foot. According to ENERGY STAR, the national industry standard for manufacturing ranges from 200 to 1,000 kBtu/square foot, so this facility is in the middle of the range. Observations made during the onsite audit also corroborate the calculated EUI value. For further information, please refer to the “Benchmarking” section.

Impact of this Study

The Foresight engineering team has identified Energy Conservation Measures (ECMs). Some ECMs identified in this report will require additional analysis to confirm costs and savings assumptions (with more detailed sub-metering and analysis, precise figures can be determined). Foresight analyzed that if ABC Company implements the ECMs below, SUBSIDIARY would be able to reduce its electricity and natural gas usage by 3% and 23% respectively, as well as reducing the GHG emission by 20%. Additionally, if ABC Company has a desire to see the holistic impact of all ECMs, it would be worth investing in building a software-enabled energy model to produce forecasted annual energy usage.

Energy Conservation Measure Summary

Below is a table showing an overview of all the measures. A description of each measure is included in the latter part of the report.

Energy Conservation Measures								
Measure	Project Cost	Electricity (kWh)		Natural Gas (CCF)		Energy Cost Savings	ROI	Tonne CO2e Reduction
		Energy Savings (kWh)	Cost/Energy Saved (\$/kWh)	Energy Savings (CCF)	Cost/Energy Saved (\$/CCF)			
LED Upgrades	\$ 3,049	44,931.24	\$ 0.070	-	\$ -	\$ 4,626	0.66	11.09
Occupancy Sensors	\$ 3,600	73,537.24	\$ 1.839	-	\$ -	\$ 6,102	0.59	18.14
Daylight Controls	\$ 1,000	4,745.68	\$ 6.364	-	\$ -	\$ 4,746	0.21	1.17
Boiler Replacement	\$ 590,000	-	\$ -	289,787.01	\$ 2.04	\$ 225,724	2.61	4,013.18
Boiler Economizer								
Pathway 1: Old Boiler	\$ 75,000	-	\$ -	205,827.78	\$ 1.04	\$ 160,325	0.47	2,850.45
Pathway 2: New Boiler	\$ 75,000	-	\$ -	176,849.08	\$ 1.24	\$ 137,753	0.54	2,449.13
AHU Replacement	\$ 171,000	136,098.90	\$ 1.256	5,450.00	\$ 31.42	\$ 18,257	9.37	109.05
AHU Economizer								
Pathway 1: Old AHU	\$ 108,000	13,609.89	\$ 8.264	8,735.00	\$ 12.56	\$ 8,205	13.16	124.33
Pathway 2: New AHU	\$ 108,000	13,609.89	\$ 8.264	8,190.00	\$ 13.43	\$ 7,781	13.88	116.78
Compressed Air Leak Repair	\$ 5,000	176,778.00	\$ 0.028	-	\$ -	\$ 22,103	0.23	43.61
VSD Air Compressor Installation	\$ 150,000	471,043.78	\$ 0.318	-	\$ -	\$ 48,494	3.09	116.21
Plug Load Sensor	\$ 12,000	18,360.00	\$ 0.650	-	\$ -	\$ 1,891	6.35	4.53
Total	\$ 1,301,649	939,104.72	\$ 2.35	480,276.09	\$ 12.03	\$ 477,476	2.73	6,882.90
Annual Facility Consumption		21,139,533.00		2,130,800.00		\$ 4,128,653.23		34,724.33
Total % Reduction			4%		23%	12%		20%



Introduction

Energy engineers from Foresight conducted an ASHRAE energy audit at ABC Company's SUBSIDIARY manufacturing facility in CITY, STATE. The auditors included Haylee Lewis and Alfred Sunaryo, who were accompanied onsite by ABC Company staff. Foresight started the audit process by conducting phone interviews with the facility personnel to get an understanding of their operations and energy usage. An onsite visit was then made to assess various energy systems, consult with onsite staff, and photograph and document equipment types and quantities.

The goals of this assessment are consistent with ABC Company's ongoing commitment to sustainability and are intended to strengthen their efforts by providing new ideas and measures via an in-depth look at all equipment and supporting processes. The assessed building systems at this facility include interior and exterior lighting, heating, cooling and ventilation, compressed air systems, controls, and building envelope.

The scope of this assessment adheres to the guidelines developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) for a Level 1 energy audit, including some aspects from a Level 2. As described in ASHRAE's Procedures for Commercial Building Energy Audits, a Level 2 "Energy Survey and Analysis" will identify and provide the savings and cost analyses of all practical energy efficiency measures that meet the owner's/operator's constraints and economic criteria, along with the proposed changes to Operation and Maintenance (O&M) procedures.

Utility analysis is performed based on historical energy bills which may cover consumption data as well as peak demand. It may also provide a listing of potential capital-intensive improvements that require more thorough data collection and engineering analysis. Cost and savings analysis is performed for each measure recommended for implementation. This level of analysis should provide adequate information for ABC Company to act upon recommendations for most buildings and for most measures.

Facility Description

ABC Company's SUBSIDIARY facility primarily consists of the office space and manufacturing plant, which includes the wastewater treatment facility. The office space operates mostly from 7 am to 5 pm on weekdays while the manufacturing floor has a 24/7 operation run time. In a year, the manufacturing plant is shut down for around 50 days for maintenance purposes and office space is also closed during national holidays. Any operations after such period only happens on rare occasions. This audit is intended to determine any opportunities for energy reduction and utility cost mitigation. The following summarize the major categories analyzed in this audit.

Building Construction

As stated above, ABC Company's SUBSIDIARY facility consists of two different spaces: office floor and manufacturing plant. The insulation consists primarily of fiberglass bats on both the roof and walls. The insulation is in a relatively good condition via the analysis with a thermal imaging camera. Most windows, especially those in the office space, are not coated with e-coating, which may serve as an area of potential energy savings.



Lighting

ABC Company's SUBSIDIARY facility has mostly been upgraded to LED lighting. There are still a few areas, mainly the mechanical and maintenance rooms, which use fluorescent or incandescent bulbs. Outdoor lights still use fluorescent bulbs also, while parking lot lights are still using incandescent bulbs and High Intensity Discharge (HID) lights. Further, during the audit it was noticed that some outdoor lights remained on even though it was daytime.

Cooling

ABC Company's SUBSIDIARY facility is unique as it has separate sections in the manufacturing floor where they differ in temperature by a significant margin due to process demand. In the spaces where it requires huge cooling capacity, a combination of Rooftop Units and Make Up Air Units are utilized to satisfy the cooling demand. The common office spaces are also cooled with the Rooftop Units and Heat Pumps with condensers while some private office spaces are mostly cooled with residential-sized split system heat pump units that have both heating and cooling capacity.

Heating

As stated in the cooling section, the manufacturing floor has spaces containing processes that require a high temperature to be maintained. To generate heat, such spaces utilize a combination of process equipment and other HVAC equipment. Process equipment produces a significant amount of residual heat that is enough to heat the space. In areas where this process heat is unavailable, unit heaters, makeup air units, and boilers are utilized as a supplement to maintain such high-level temperatures. Most office spaces utilize split system heat pumps for heating purposes.

Compressed Air System

Compressed air is another major component of SUBSIDIARY electricity footprint. Many organizations are utilizing multiple compressors to satisfy their needs for manufacturing and process equipment. SUBSIDIARY has several compressors over 100 HP in size and a variety of both fixed speed and variable speed drive motors, and controls systems.

Manufacturing

The manufacturing space of SUBSIDIARY facility has several processes that are relevant to infant formula production. Such processes are:

1. Wastewater treatment – Several pumps with VFD and sulfuric with bacterial treatment
2. Manufacturing – Large evaporators and dryers without insulation
3. Storage – Large tanks and pipes without insulation

Utility and Emission Factor Summary

Electric and natural gas utility data was reviewed from April 2022 – March 2023 period. The electricity and natural gas used and delivered are being charged at different rates due to the fluctuation of usage. Hence, the information below is presented as the average rate over the 12-month period. The electric rate varies based on the season and on/off peak hours while the natural gas rate changes each month. Each energy conservation measure is assessed with the actual energy costs incurred by ABC Company over this period. Also, every quantified ECMs in this report is provided with the tonne CO₂e (GHG) reduction to further support ABC Company's ongoing commitment for sustainability.



Utility Provider Information

Location	Electricity	\$/kWh	Natural Gas	\$/CCF
ABC Company SUBSIDIARY	Green Mountain Power	\$ 0.10295	STATE Gas	\$ 0.77017

Annual Utility Data

As mentioned in the preceding paragraph, the electric rate is influenced by the kWh consumption during the on/off peak hours of Green Mountain Power. A peak demand analysis could be performed to reduce the annual electricity cost. This approach would analyze the annual electric consumption based on the on/off peak demand and provide a more thorough insight on how to reduce the demand charges cost. Indirectly, this analysis would highlight opportunities for energy efficiency improvement. In parallel with electricity bills, STATE Gas charges a different rate per month for natural gas. The summary of annual utility cost can be observed in the table below.

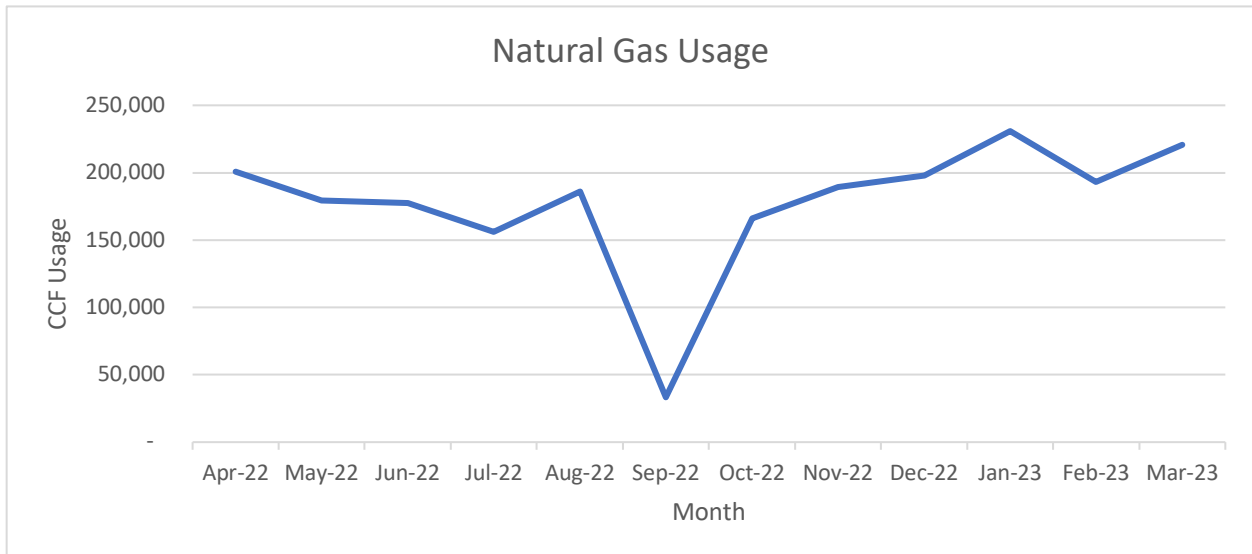
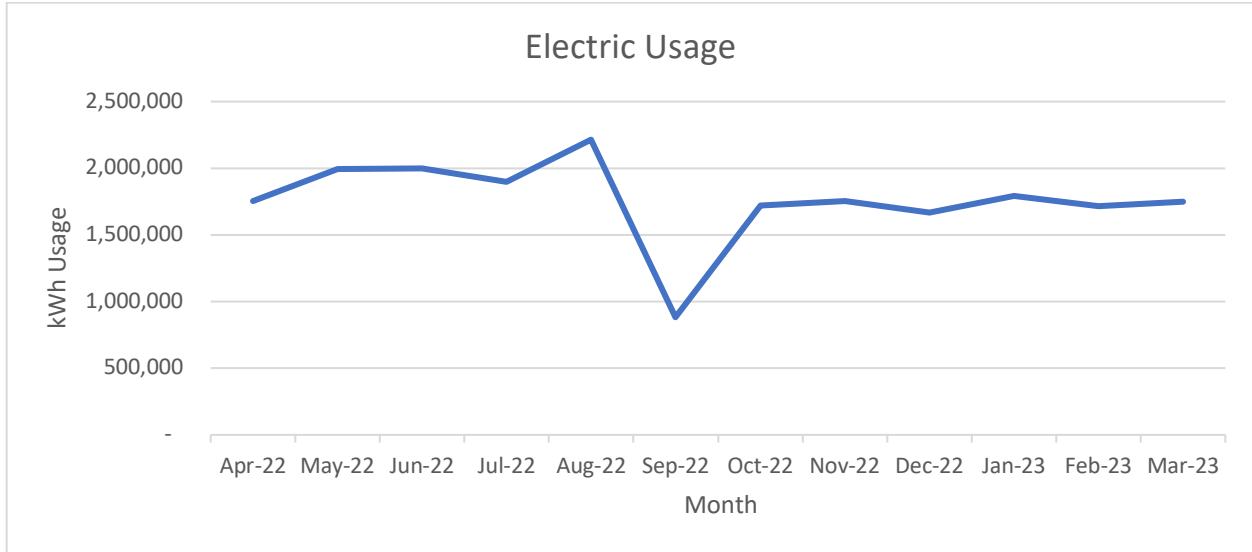
Electricity		Natural Gas		Total Cost
Usage (kWh)	Cost	Usage (CCF)	Cost	
21,139,533	\$ 2,487,582.12	2,130,800	\$ 1,641,071.11	\$ 4,128,653.23

Foresight previously provided ABC Company with a detailed Rate and Procurement report for all locations. Additional utility analysis is included in this report to compare the relative utility usage, both electric and natural gas, of the SUBSIDIARY facility to the rest of ABC Company's non-Michigan facilities. As presented in the table above, SUBSIDIARY uses around 21,000,000 kWh of electricity and 2,200,000 CCF of natural gas annually with each utility costs around \$2,500,000 and \$1,650,000, respectively. All non-Michigan facilities use around 39,000,000 kWh of electricity and 2,950,000 CCF of natural gas and cost around \$5,000,0000 and \$1,660,000, respectively. **These numbers indicate that SUBSIDIARY utilizes around 50% of electricity and 70% of natural gas of ABC Company's non-Michigan facilities utility usage.**

Energy Use Analysis

The graphs below chart the electricity and natural gas usage of ABC Company's SUBSIDIARY facility. Based on the data, it shows that there is no significant seasonal effect on electric usage and natural gas usage. However, as observed in the chart below, there is a significant usage drop in both electricity and natural gas in September. Foresight understands that this drop occurs due to the routine plant shut down for maintenance purposes. Natural gas has a small seasonal component to it as usage in the winter months is slightly higher due to heating needs.





GHG Emission Factor:

Fuel Type	Location	CO2	Unit	CH4	Unit	N2O	Unit
Natural Gas	USA	0.005502322	Tonnes CO2 per CCF	0.000058331	Tonnes CH4 per CCF	0.008288065	Tonnes N2O per CCF
Electric	Vermont	0.0002447	Tonnes CO2 per kWh	0.000000825	Tonnes CO2 per kWh	0.000001192	Tonnes CO2 per kWh

GHG Emission Calculation:

A general formula for calculating emissions is:
 ActivityData X Emissions Factor X Global Warming Potential (GWP) = GHG Emissions (CO₂e)



Benchmarking

ENERGY STAR and Energy Use Index (EUI)

For certain common building occupancies such as offices and warehouses, the ENERGY STAR Performance Rating is a useful methodology to benchmark a building against other similar-use buildings. ENERGY STAR is a national energy performance rating system and serves as an external benchmark that helps energy managers assess how efficiently their buildings use energy relative to similar buildings nationwide. However, this might not be the case for manufacturing facilities, such as the one analyzed in this report.

Another benchmark that is useful, especially for comparing year-over-year performance, is the Energy Use Index (EUI), which represents total energy in kBtu per square foot. To calculate the EUI, the normal measure of electricity use, kWh, is converted to BTU/hr to have the same units as natural gas usage. As stated above, according to ENERGY STAR, the national industry standard for manufacturing ranges from 200 to 1,000 kBtu/square foot the average EUI for a manufacturing facility, while ABC Company has an EUI of 463 kBtu/square foot. The lower number indicates that the building is already operating at much higher efficiency.

From the GHG emission perspective, this facility produces 34,725 tonnes of CO₂e. Should ABC Company decide to implement the ECMs recommended in this report, SUBSIDIARY site would be able to reduce its GHG emission by 20%. This number is quite significant as typically this audit would only reduce around 10%-15% GHG emission.

Below is a table that summarizes the EUI for the ABC Company facility in CITY, STATE. Utilizing this table as a prioritization tool for energy efficiency opportunities across the organization is one way the leadership team at ABC Company can leverage this information.

Location	Square Footage	Energy Use Index (kBtu/sqft)
ABC Company SUBSIDIARY (STATE)	160,500	463
ABC Company SUBSIDIARY 2 (STATE)	108,831	215

Further investigation is required to gain a more thorough understanding behind the discrepancy in the EUI number between SUBSIDIARY and SUBSIDIARY 2. If the production level between the two facilities has a negligible difference, considering the size difference of the facilities and comparing each associated EUI, SUBSIDIARY in STATE is operating at almost the same efficiency as SUBSIDIARY 2 in STATE.



Energy Conservation Measure (ECM) Overview

This section discusses the Energy Conservation Measures (ECMs) that Foresight identifies based on the onsite visit to the SUBSIDIARY facility. These ECMs are summarized after Foresight has consolidated and analyzed the data gathered, including utility data, which then will be organized based on their payback period. Some ECMs listed below are found to have minimal savings when compared to the capital costs or complex design aspects, which require more in-depth information such as submetering data, process equipment usage, etc. Therefore, such ECMs were not quantified. Note, Green Mountain Power (The electricity utility) does not have a prescriptive rebate program; any potential savings must be applied through the custom rebate program.

Payback Period 0-2 years:

LED Lighting Upgrades

LED is the current efficient lighting solution over T8 fluorescent. Although most of the lighting has been upgraded to LED, there are still multiple spots that can be upgraded to LED. This includes parking lot lights and outdoor fixtures. Below is the budget that represents the remaining fixtures observed.

Budget (±30%):

Initial Cost:	\$3,049
Energy Savings (Per year):	44,932 kWh
Cost Savings (Per year):	\$4,626
Simple Payback:	0.70 Year
Cost/kWh saved:	\$0.07/kWh
Tonne CO ₂ e Reduction:	11.1 Tonnes

Occupancy Sensors for Lighting

There are many areas at SUBSIDIARY where the lights were on, but there were no people in the space. Some of these spaces include break rooms, storage, bathrooms, and offices. Occupancy sensors could be extra effective in the storage area attached to the paint area seeing as the lights were on in that area, yet the space is rarely occupied. Foresight does not recommend that ABC Company installs occupancy sensors in the production floors as that might pose safety issues.

Budget (±30%):

Initial Cost:	\$3,600
Energy Savings (Per year):	73,538 kWh
Cost Savings (Per year):	\$6,102
Simple Payback:	0.59 Year
Cost/kWh saved:	\$1.84/kWh
Tonne CO ₂ e Reduction:	18.14 Tonnes



Daylight Lighting Controls

During sunny days, daylight sensors could be used to turn off lights while maintaining working light levels. On days where there is not much sun exposure, the current LED would adjust to the appropriate levels to continue consistent light levels of the space.

Budget ($\pm 30\%$):

Initial Cost:	\$1,000
Energy Savings (Per year):	4,746 kWh
Cost Savings (Per year):	\$4,746
Simple Payback:	0.21 Year
Cost/kWh saved:	\$6.36/kWh
Tonne CO ₂ e Reduction:	1.17 Tonnes

Boiler Stack Economizer

Any lost heat associated with the operation of the boiler system rises through the boiler stack and is exhausted outside. This heat can be recovered through a boiler stack economizer to heat domestic water or pre-heat the boiler feed water. This reduces the energy consumption associated with domestic hot water or boiler operation. This report presents two pathways for ABC Company to pursue: Economizer for Old Boilers (Pathway 1) and Economizer for New Boilers (Pathway 2). Each of these pathways has its own individual budget and will be presented below.

Pathway 1 Budget ($\pm 30\%$):

Initial Cost:	\$75,000
Energy Savings (Per year):	205,828 CCF
Cost Savings (Per year):	\$160,325
Simple Payback:	0.47 Year
Cost/CCF saved:	\$1.04/CCF
Tonne CO ₂ e Reduction:	2,851 Tonnes

Pathway 2 Budget ($\pm 30\%$):

Initial Cost:	\$75,000
Energy Savings (Per year):	137,753 CCF
Cost Savings (Per year):	\$137,753
Simple Payback:	0.54 Year
Cost/CCF saved:	\$1.24/CCF
Tonne CO ₂ e Reduction:	2,449 Tonnes



Compressed Air Leak Repair

Compressed air systems are prone to leaking. Foresight has performed a compressed air leak audit, which will allow the ABC Company team to repair the leaky section of the compressed air infrastructure. These leaks were detailed in a brief report and provided to the ABC Company team in April 2023, shortly after the audits were performed.

Budget (±30%):

Initial Cost:	\$5,000
Energy Savings (Per year):	176,778 kWh
Cost Savings (Per year):	\$22,103
Simple Payback:	0.23 Year
Cost/kWh saved:	\$0.028/kWh
Tonne CO2e Reduction:	43.61 Tonnes

VFD Sequencing Check

Many pumps, including the ones used for process water and wastewater treatment systems, are connected to Variable Frequency Drives (VFDs). Upon looking at the behavior of the driver, it is possible that the VFD is running inefficiently due to internal settings. Checking that this device is running optimally would ensure the energy efficiency savings that the device provides.

HVAC Setpoint Unification

In several open office areas, there were multiple thermostats for controlling the temperature. During the time Foresight was onsite, it was observed that in some of these areas the thermostats serving the same space had different setpoints. This would cause one of the units to run more often, and it is not sized to heat/cool the entire space. Having the setpoints match would allow for the multiple units to work in unison, more effectively heating or cooling the entire area.

Payback Period 2-5 years:

VSD Air Compressor Installation

ABC Company's SUBSIDIARY facility has air compressors, however they are not equipped with Variable Speed Drives (VSDs). The absence of VSD indicates that there are times in the air demand profile when the system is running inefficiently. This is due to the inability of the system to match its production with the plant's production needs. Installing the VSD to all air compressors would result in a more efficient air system because air production could exactly match demand.

Budget (±30%):

Initial Cost:	\$150,000
Energy Savings (Per year):	471,044 kWh
Cost Savings (Per year):	\$48,494
Simple Payback:	3.09 Year
Cost/kWh saved:	\$0.318/kWh
Tonne CO2e Reduction:	116.21 Tonnes



Boiler Replacement

The three boilers in the SUBSIDIARY facility could be replaced for energy savings. The boilers are rated at 81% efficiency and due to age are likely running closer to 75%. Also, the facility is only running two boilers at a time, with the other boiler acting as an emergency backup boiler. New high efficiency steam boilers operate in the 80%-85% efficiency range, and this represents an opportunity for energy savings.

Budget ($\pm 30\%$):

Initial Cost:	\$590,000
Energy Savings (Per year):	289,787 CCF
Cost Savings (Per year):	\$225,724
Simple Payback:	2.61 Year
Cost/CCF saved:	\$2.04/CCF
Tonne CO ₂ e Reduction:	4,032 Tonnes

Pipes and Tanks Insulation

The boiler pumps hold hot water before it is pumped into the boiler. Insulation should be installed properly on these tanks due to the large heat loss associated with tanks. However, due to biological safety concerns, the insulation chosen must satisfy the cGMP standards and codes. Perlite-based insulation could serve such a role. Furthermore, the ducts insulation could be improved at the facility.

Tighten Up Building Envelope

There might be multiple spots in the office space where the walls have been compromised resulting in free flow of air in from outside, which indicates that they are lacking in insulation. The majority of the windows are lacking in e-coating, which can contribute to the significant temperature and humidity fluctuation in such areas.

Variable Air Volume (VAV) System Evaluation

Variable Air Volume (VAV) box is a type of system control that could regulate the heated/cooled air produced from the HVAC units, such as Furnace, Rooftop Units, etc. A VAV box is programmed to operate between a minimum and maximum airflow setpoint and can modulate the flow of air depending on occupancy, temperature, or other control parameters. With this system installed, the flow of air would become much more efficient and allow further energy savings. It is unclear whether SUBSIDIARY have this system installed or not, due to the lack of mechanical information of the building. Hence, it is advisable for ABC Company's onsite maintenance team to investigate the availability of VAV system.

Payback Period 5+ years:

Air Handling Unit (AHU) Replacement

Replacing the existing unit with an efficient roof top unit could result in additional energy savings. Most of the available units at the facility have a SEER of 14, and more recent condensers are rated as high as



18 SEER (almost a 50% reduction in energy consumption). Although there are units at the SUBSIDIARY facility that are still relatively new, the reduction of energy consumption might justify the capital cost of installation.

Budget (±30%):

Initial Cost:	\$171,000
Energy Savings (Per year):	136,099 kWh and 5,450 CCF
Cost Savings (Per year):	\$225,724
Simple Payback:	2.61 Year
Cost/Unit Energy saved:	\$1.26/kWh and \$31.42/CCF
Tonne CO2e Reduction:	109.05 Tonnes

Air Handling Unit (AHU) Economizer

There are multiple AHUs in the facility that are not equipped with economizers. By installing economizers and controls, these units can capitalize on free cooling as well. Economizers are especially effective in office settings where cooling may still be needed during cooler times of the year due to the large quantity of heat generated by plug load, lighting, and occupancy. This report also presents two pathways for ABC Company to pursue: Economizer for Old AHUs (Pathway 1) and Economizer for New AHUs (Pathway 2). Each of these pathways has its own individual budget and will be presented below.

Pathway 1 Budget (±30%):

Initial Cost:	\$108,000
Energy Savings (Per year):	13,610 kWh and 8,735 CCF
Cost Savings (Per year):	\$8,205
Simple Payback:	13.16 Year
Cost/Unit Energy saved:	\$8.27/kWh and \$12.56/CCF
Tonne CO2e Reduction:	124.33 Tonnes

Pathway 2 Budget (±30%):

Initial Cost:	\$108,000
Energy Savings (Per year):	13,610 kWh and 8,190 CCF
Cost Savings (Per year):	\$7,781
Simple Payback:	13.88 Year
Cost/Unit Energy saved:	\$8.27/kWh and \$13.43/CCF
Tonne CO2e Reduction:	116.78 Tonnes

Plug Load Sensor

At numerous stations around the facility there were fans, task lights, and other equipment left on. This was occurring during shift hours and appeared to happen between shifts as well. There are power strips available with a connected occupancy sensor. These would attach to a computer and power down peripheral equipment, while away from the desk. This would not shut down the computer, or other main devices, you could plug into fully powered outlets.

Budget (±30%):



Initial Cost:	\$12,000
Energy Savings (Per year):	18,360 kWh
Cost Savings (Per year):	\$1,891
Simple Payback:	6.35 Year
Cost/kWh saved:	\$0.065/kWh
Tonne CO2e Reduction:	4.53 Tonnes

Demand Control Ventilation

Spaces are designed to properly ventilate an area during maximum occupancy times while these times are rarely experienced. Demand Control Ventilation can be used to reduce outdoor fresh air requirements to a space by controlling the outdoor air damper of a unit based on the CO₂ levels in a space. As people breathe out CO₂, the controller and sensor work to adjust the damper position to provide the correct amount of outdoor air for the current space occupancy.

Refurbish or Replace Cooling Tower

The cooling tower is showing signs of age and should be refurbished or replaced. The media within the cooling tower has biological growth causing a drop in efficiency. Furthermore, it appears that the dispersion pans at the top of the tower are clogged and causing the water to come down incorrectly and leak onto the ground. By fixing these two issues, the cooling tower efficiency would increase drastically.

Solar PV Installation

Solar is a great avenue to explore if ABC Company is looking for a way to meaningfully reduce the amount of purchased electricity at the facility. The cost of solar has decreased significantly over the past decade. Additionally, the federal government offers a 30% tax credit for the installation of solar. Although SUBSIDIARY has considered ground-mounted solar, it is still worth noting that since solar PV systems and roofs both have a useful life of about 25 years, the age and structural health of the roof should be evaluated before considering roof-top solar.

Process Evaluation

Battery Storage/Expansion Tank

A process steam system at manufacturing facilities usually runs at a much higher pressure than required. Based on the pressure difference, it can be observed that excess steam and energy has been wasted. To combat this problem, a turbine or expansion tank maybe be installed. The turbine will lower the steam pressure to the closer required number while generating electricity at the same time. However, should there is any excess from the generated electricity, which could cause concerns from electric utility provider. A solution could be implemented to avoid such problems, by directing the generated electricity to battery storage for future use.



Should the turbine be installed, the generated electricity can be directed and stored in the battery storage. With this device, this site would not be viewed as an electricity provider, which would avoid any potential issues with Green Mountain Power, for as long as the generated electricity is not returned to the main electrical grid. If the generated electricity is returned to the main grid, Green Mountain Power would exact a harsher rate on SUBSIDIARY and other procurement problems. On the other hand, a simpler option is to install the expansion tank. This tank would lower the steam pressure with minimal steam loss and virtually no impact on the overall process.

Cogeneration (CHP) Installation

Cogeneration is the use of a heat engine, such as boilers, to generate electricity and useful heat at the same time. This system allows a more efficient use of natural gas as it recovers wasted heat from the steam for heating purposes. Such heat at moderate temperatures (212°F –356 °F) may even be used for cooling purposes through absorption refrigerators. Absorption refrigerators will use this heat source to provide the energy needed to drive a cooling process. Coolants, usually glycol, in its heat exchanger systems will absorb the heat and use it to perform evaporative cooling, which would lower air temperature. With this system, a facility could achieve total process efficiency of 65% to 80%. As this system requires less natural gas, it could reduce the GHG emissions by quite a large margin (around 40%). This system would also allow the recovered heat to be used for manufacturing purposes, such as dryers/evaporators.

Water Treatment System

This site has two water treatment systems: process water sanitization and wastewater treatment. In the process water sanitization system, the city water is directed to the brine tank and reverse osmosis system is used to remove any unwanted particulates from the water, resulting in a higher purity water that is suitable for SUBSIDIARY facility use. While this method certainly meets the cGMP standards, another improvement could be implemented. Installing the UV-Water sanitation system in addition to the brine tank and reverse osmosis would result in an even purer water. From an energy efficiency perspective, this equipment would allow the used water to be conserved. Hence, less city water would be consumed and the energy usage to pump city water into the process would decrease.

SUBSIDIARY facility also has an extensive wastewater treatment system, which includes many pumps and sulfuric treatment to mitigate the environmental impacts of wastewater generated from the site. As mentioned in the above paragraph, this site relies on electrical pumps to satisfy both the process water and wastewater demands, which indicates that VFD installation and sequencing check should be implemented to maximize the effect of energy efficiency measures.

Marriott Walker Dryers/Evaporators

Industrial dryers/evaporators are used to efficiently process large quantities of bulk materials that need reduced moisture levels. Various factors are considered in determining the correct type of dryer for any given application, including the material to be dried, drying process requirements, production requirements, final product quality requirements, and available facility space. SUBSIDIARY facility has multiple dryers/evaporators to meet the process demand. Based on the audit visit, the Foresight team observed that this equipment is made by Marriott Walker, and they are using fluidized bed technology.



This technology essentially used pressurized fluid into solid particles, which would allow separation process to happen, therefore creating reduced moisture powder products.

To evaluate the energy usage of this equipment, several factors need to be considered to perform a successful analysis: blower size, regeneration desiccant, and aftercooling circuits. Quantification of this analysis would require more in-depth analysis. CHP system installation (see “Energy Conservation Measure (ECM) Overview” section) could be used to reduce the amount of natural gas utilized to operate the dryers.

Steam Trap Installation/Tune-Up

A steam trap is a device used to discharge condensates and non-condensable gases with a loss of process steam. It allows the process system to continuously remove the condensate formed inside the system, which allows SUBSIDIARY to reduce the energy loss due to residual steams and even track any previously unaccounted energy and material lost. The recommended type of steam trap is a float-thermostatic trap due to its ability to pass large volumes of water condensate at relatively low pressure.

Conclusion and Recommendations

Foresight Management recommends ABC Company to pursue the following next steps to further advance their sustainability and energy efficiency initiatives at SUBSIDIARY. Should ABC Company pursue these next steps, Foresight can assist.

1. ECM Implementation/Refinement

Foresight’s team has formulated many ECMs that can be implemented with relatively low/no costs with reasonable payback periods. Should SUBSIDIARY apply all these ECMs, a decrease in utility usage would be seen, both electric and natural gas. It is also imperative to conduct ongoing performance reviews to see and correct developing problems as well as adapt to the ever-changing production practices.

2. Thermal Imaging Study

Perform a thermal imaging study to gain more thorough observation on the insulation condition and detect any leakage on the duct systems of the building to gain a better understanding on the effectiveness of the ducts in circulating air in and out of the various HVAC systems. Should any leakage be found, several steps, such as insulation, can be taken to remedy the problem.

3. Sub-metering Installation

Add sub-metering for key energy users to obtain a more thorough understanding of the energy usage in the building complex. Installing active sub-meters helps increase understanding and make well-informed decisions around capital expenditures of each building. Recommended systems to monitor are the office space and manufacturing floor, with lighting, HVAC, and process equipment as the focus. Power monitoring should also be used for a more precise



measurement of power usage. This will also help predict future equipment failure to avoid costly, unplanned shutdowns of various HVAC equipment.

4. **Peak Demand Analysis**

Demand charges are another contributing factor to utility costs. It was observed during utility data review that electric demand makes up a larger portion of utility bills. A peak demand analysis could be performed to analyze the annual electric consumption based on the on/off peak demand. This study would provide a more thorough insight on how electricity is used at the facility, leading to potential cost reduction opportunities.

5. **Duct Blaster Testing**

Perform duct blaster testing to detect any leakage on the duct systems of the building to gain a better understanding on the effectiveness of the ducts in circulating air in and out of the various HVAC systems. Should any leakage be found, several steps, such as insulation, can be taken to remedy the problem.

6. **Green Building Certification**

Apply for Green Building Certifications, such as LEED and WELL certifications, for the SUBSIDIARY' site. A LEED certified site will lower energy usage of the facility by around 25%. All the ECMs identified in this report will be further analyzed through energy modeling and can also be done in conjunction with the LEED certification. This lower energy usage will also reduce the GHG emission produced from this site, which further supports ABC Company's ongoing sustainability commitment. Besides their financial and environmental benefits, these certifications will also increase the comfort level of its occupants. Foresight has a team of specialists that can further assist the ABC Company team should this option is pursued.

7. **Green House Gas (GHG) Emission Reduction Analysis**

GHG emission reduction analysis is another next step for ABC Company's sustainability journey. This study would allow the ABC Company team to identify all pathways to achieve a net zero emission should ABC Company decide to set this goal. It is worth acknowledging that even though energy efficiency measures are effective in reducing the energy usage of SUBSIDIARY facility, it is still insufficient for further reduction in the GHG emission. Hence, this study is necessary for a more tangible result in GHG reduction and ABC Company's sustainability journey.

