



HYSTER-YALE
M A T E R I A L S H A N D L I N G

Becoming a “Steward” & Pollution Prevention Project Implementation

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STEPHEN KELLY
SR. EHS MANAGER

STEPHEN.KELLY@HYSTER-YALE.COM
(252) 417-1517



GREENVILLE MANUFACTURING PLANT



- 600 Full Time manufacturing Employees, total headcount of around 800 employees
- Manufacture roughly 1,600 forklifts/month
 - Product design, welding, paint, assembly, and shipping
- Celebrated our 20 Year Anniversary as part of the NC ESI Program in 2024
- Celebrated our 50 Year Anniversary at our Greenville plant in 2024
- Facility has produced electric lifts only since 2005



WELD



PAINT



ASSEMBLY



HYSTER-YALE VISION STATEMENT

Transforming the way the world moves materials from Port to Home.

Transformation focused on reducing the impact of material movement on people, the environment, and the economy, all driven by the imagination and creativity of our team.



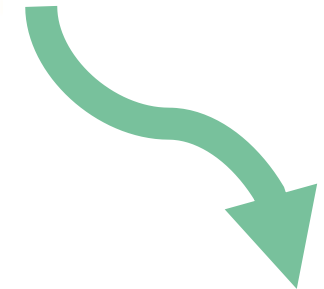
The choices and investments we make prioritize the safety and wellbeing of our employees, our customers and our communities. This approach is foundational to our business and ensures strong and effective corporate responsibility.

We have embedded environmental and social matters into our governance strategies, incorporating cost-effective corporate responsibility throughout our organization.

In doing so, we are able to contribute to solving global challenges which impact our customers and our communities, but also serving the best interests of our company and our shareholders.

GROWING WITH ESI

- ▶ **20 Years as Rising Steward**
- ▶ **EMS System, ISO 14001:2015 Certified**
- ▶ **Robust Goals**
 - ▶ Carbon Emission Reduction
 - ▶ Zero Waste to Landfill
 - ▶ VOC Reduction
 - ▶ Water Consumption Reduction
 - ▶ Hazardous Waste Reduction
- ▶ **NOVs though...**
 - ▶ RCRA & Industrial Wastewater issues
 - ▶ Air Permit & Stormwater issues
- ▶ **How about that Community Involvement and Mentoring Requirement?**



INDUSTRIAL SEWER – WASTEWATER IMPROVEMENTS

- ▶ Discharge around 120,000 gallons of industrial wastewater per month
 - ▶ Limit of 10,000 Gallons per day
 - ▶ Multiple “Flow Violations” for exceeding daily limit
- ▶ New flow meter, with SCADA system, sim card, alerts and limits



STORM WATER IMPROVEMENTS

- ▶ Stormwater retention pond improvements to ensure continued compliance
 - ▶ Regrowing grass on banks in areas that have been worn away
 - ▶ Removal of woody shrubs and trees along banks
 - ▶ Filling of animal burrows on banks
 - ▶ Adding riprap to prevent erosion around outfall



- ▶ Labeling issues
 - ▶ “Waste oil, Hazardous waste aerosols, light bulbs”
- ▶ Central Accumulation Area Inspections
- ▶ Central Accumulation Area Organization
- ▶ Elimination of Hazardous Waste Solvent Wipes

**EXCLUDED
SOLVENT-
CONTAMINATED
WIPES**

Empty container on Fridays/Saturdays when doing booth PM. Ensure that there are no "Free-Liquids" contained in the rags before they are disposed of in the trash.

NO LIQUIDS CAN BE PLACED IN THIS CONTAINER!



WOOD WASTE RECYCLING

- ▶ Recycled 1,027 Tons of wood waste in 2023
- ▶ Recycled 1,136 Tons of wood waste in 2024



SCRAP STEEL RECYCLING

- ▶ Recycled 1,570 Tons of scrap steel in 2023
- ▶ Recycled 1,700 Tons of scrap steel in 2024
- ▶ In 2025 we have several projects focused on returnable steel pallets



ECU CSE3 PARTNERSHIP

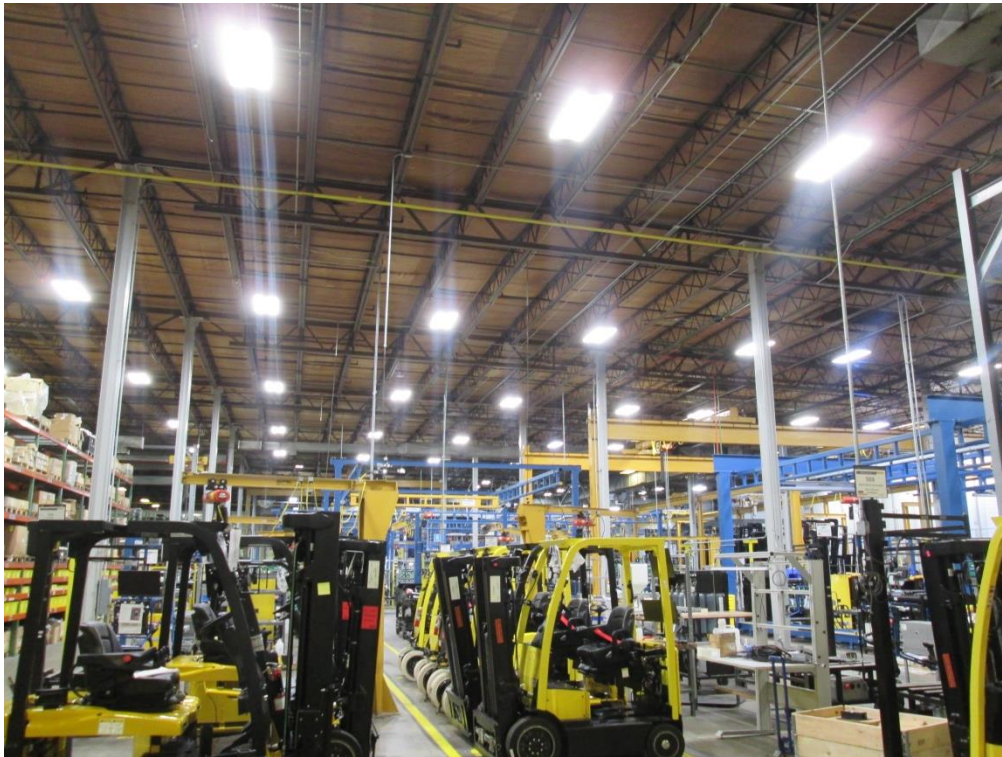
- ▶ Hosted our 1st Sustainability Engineering Intern in Summer of 2023
- ▶ His focus was carbon reduction
- ▶ Researched solutions, cost of implementation, payback period, etc.



A.R No.:	Description	Average Implementation Cost (\$)	Average Annual Savings (\$)	Simple Payback Period (years)
1	Installing LED	\$57,200.00	\$138,092.64	0.41421469
2	Lighting Schedule	\$0.00	\$59,904.00	-
3	Solar Energy System Improvements	\$93,633.75	\$13,413.80	6.98040451
4	Chiller Improvements	\$52,400.00	\$18,000.00	2.91111111
5	Air Compressor Improvements	\$0.00	\$5,730.6228	-
6	Roof and Wall Insulations	\$100,000.00	\$113,733.00	~ 10.5
7	Installing Occupancy Sensors	\$1,050.00	\$1,044.19	1.005562195
8	Oven Insulation	\$2,100.00	\$540.054	3.8885
9	Installing Skylight	\$240,000.00	\$15,417.60	15.56662516
10	Geothermal Heat Pump	\$53,200.00	\$30,142.20	1.7764967388
11	Water Consumption	\$8,500.00	\$960.00	8.85416667
12	Natural Gas Consumption	\$53,200.00	\$23,542.20	2.25977181

LED LIGHTING UPGRADES

A.R No.:	Description	Average Implementation Cost (\$)	Average Annual Savings (\$)	Simple Payback Period (years)
1	Installing LED	\$57,200.00	\$138,092.64	0.41421469



Section 1: Intro and client objectives

The goal for this project was to find ways to limit the pollution created and to save the company money.

The secondary goal is, if possible, help this plant achieve their zero waste to landfill initiative.

Section 2: Methods and scope

I worked with the Environmental Health and Safety Team along with the Maintenance Team at the plant to identify problems that sound be fixed.

This site had an intern last summer, so some aspects had already been covered. This means that the plant had some idea of what could be looked at which was a helpful starting off point.

There was a second intern at the plant, so we split the load of what was to be looked at.

I mainly focused on the **chiller**, **solar**, **reusable absorbents**, and **compressed air leaks**.

Tools Used:

FLIR Thermal Camera
Whisper Ultrasonic Air Leak Detector
Temperature Gun
Lazer Measuring Device
Excel Calculation Files
The Other Interns

Acknowledgements

I would like to thank everyone at the plant for being so welcoming and helpful

Section 3: Recommendations

The recommendations in the table below are a combination of the more ambitious projects and the ones that are easiest to implement

AR No.	Description	Average Annual Savings (in \$)	Average Implementation Cost (in \$)	Simple Payback Period (years)
1	Increase Concentration for Blowdown on chiller	\$1,295.88	-	-
2	Change Chemical Treatments for Chiller	Variable	Variable	-
3	Solar installation	\$180,869.06*	\$1,198,611*	6.6
4	Reusable absorbents	~ \$3000**	\$57,600	-
5	Compressed air system	\$107,827.20	≤\$5,000	2.4 weeks

*Average of all designs

** Conservative estimate based on my own math. Cost savings estimated by ITU AbsorbTech is about \$25,000

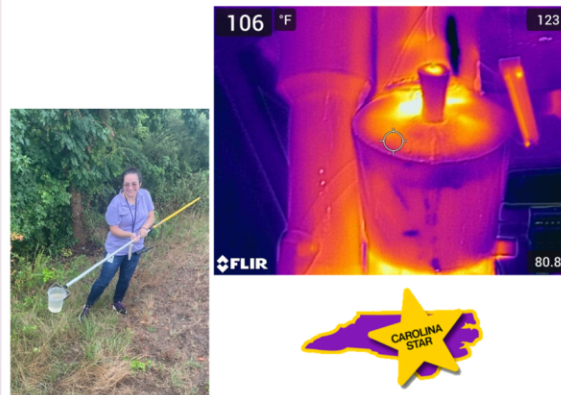
Other recommendations:

- ❖ Add insulation to the pipes in the chiller room
- ❖ Fix the air handler so that the chiller can work more efficiently
- ❖ Try peat moss for oil absorption
- ❖ Reduce paint overspray
- ❖ Add can crushers to the break rooms to recycle aluminum cans
- ❖ Add recycling for paper and plastics
- ❖ Sell byproducts, such as used cooking oil, to waste to energy programs

Section 4: Conclusion and key takeaways

By acting on the recommendations that cost less, more money is available for the more expensive ones.

This plant already has several green initiatives ongoing and seemed receptive to many of the recommendations



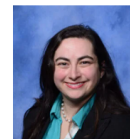
Description	Average Annual Savings (Produced*) (kW)	Average Annual CO2 Savings (tons)
Add insulation to pipes in the chiller room	96,480	74.3
Solar Design, largest	4,804,495*	3,700
Solar design, smallest	1,334,516*	1,028
Compressed air leaks	1,347,840	619

References

"Greenhouse Gas Equivalencies Calculator," EPA, January 2024. [Online]. Available: <https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator/factsheet>.
J. Felber, Interviews, Update to blowdown numbers, email. [Interview]. 21 June 2024.
"Business Energy Investment Tax Credit (ITC)," 29 August 2023. [Online]. Available: <https://programs.chenusa.org/hyterm/program/detail/656/business-energy-investment-tax-credit-ito>.
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Center for Sustainable Energy & Environmental Engineering

Student Spotlight



An Exceptional Student Nearing Graduation!

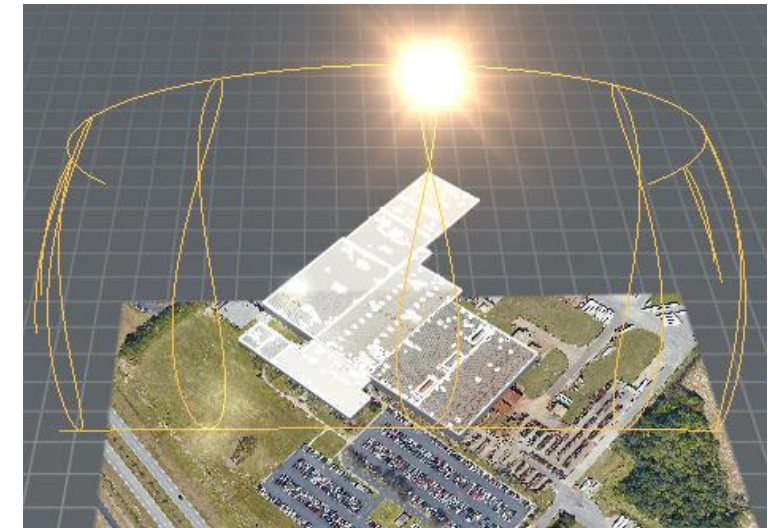
The center is thrilled to bring to the spotlight Ms. Ellie Aronson, one of our most dedicated students. She has been with us since January and is set to graduate on December 13 with a BS in Engineering, concentrating in Environmental Engineering. As a research assistant for the Pollution Prevention Team at CSE3, Ellie has contributed to various initiatives, including the P2 internship program. She has also been actively working on the cost-benefit analysis for the P2 internship reports.

Ellie shared that her time with us has been both rewarding and enjoyable. In her words, "I have learned a lot and gained consulting and industry experience that I would not have had otherwise. I have greatly enjoyed my time here." We are incredibly grateful for her hard work and the valuable contributions she has made to the center. As she prepares to transition to the next chapter of her career, we wish her great success in all her future endeavors.

SOLAR ARRAYS



Location	Array size, kW	kWh per year production	Cost Estimate	Average Annual Savings (in \$)	Simple Payback Period (years)	Tons of CO2 avoided
Main plant full roof	3,341	4,804,495	\$2,639,938	\$398,391.71	6.6	3,700
Main Plant Fab roof	928	1,334,516	\$733,271.90	\$110,658.90	6.6	1,028
MHC roof	970	1,394,913	\$766,458.9	\$115,667.05	6.6	1,074
Ground mounted MHC	1,368	1,967,253	\$1,081,394	\$163,125.84	6.6	1,515
Ground mounted main plant	977	1,404,980	\$771,989.90	\$116,501.81	6.6	1,082



CHILLER ROOM

- ▶ Uses roughly 150,000 additional gallons of water per month in summer compared to non-summer months



AR No.:	Description	Average Implementation Cost (\$)	Average Annual Savings (\$)	Simple Payback Period (years)
4	Chiller Improvements	\$52,400.00	\$18,000.00	2.91



Section 1: Intro and client objectives

- ❖ The facility spans ¾ of a million square feet and employs approximately 850 people. As a manufacturing and distribution center, it specializes in producing a range of lift trucks.
- ❖ The client's primary objectives for the Greenville Hyster-Yale facility are to implement the Building Management System (BMS) to enhance energy efficiency, reduce operational costs, and improve sustainability.

Section 2: Methods and Tools

- ❖ The primary methods used to collect data for the following recommendations included utilizing a FLIR infrared gun, an environmental multimeter and analyzing preexisting data from the plant such as utility bills and archived information.
- ❖ This assessment utilized a qualitative approach, detailed interviews with managers and review of existing documents, and direct observations.
- ❖ The assessment began with a walk-through of the plant to identify all systems controllable via the Building Management System (BMS). Following this, meetings with managers were conducted for pre-existing issues or potential areas for cost reduction. Lastly, utility bills were reviewed to determine the most heavily used utilities.



Acknowledgements

I would like to thank everyone at Hyster-Yale for their partnership and support of ECU Engineering. Also everyone at the center who had helped this summer getting all of our stuff checked and finalized.

Section 3: Top 5 Recommendations

AR No.	Description	Implementation Cost (\$)	Annual Savings (\$)	Payback Period
1	Put Office Lights On Schedule	\$1000	\$4,590.00	2.6 months
2	Low-E Film On Exterior Windows	\$7,911.67	\$2,696.64	2.9 years
3	Put Lights In Manufacturing Area On Schedule	\$3500	\$18,763.00	0.19 years
5	Reduce Plant's Operating Pressure	\$1000	\$69,133.50	0.014 years
7	Putting Office HVAC On Schedule	\$ 124965	\$114,533.34	1.09 years

- ❖ The coding completion of the Building Management System (BMS) at the Greenville Hyster-Yale facility will result in several recommendations for enhancing energy efficiency and sustainability. These include,

AR No.	Description	Implementation Cost (\$)	Annual Savings (\$)	Payback Period
4	Keeping all loading doors closed when not in use	\$0.00	\$944.40	0.0 years
6	Adjust Greenville utilities Electricity rate	N/A	\$78,058.88	N/A

Section 4: Conclusion

- ❖ Next steps involve engaging with the Greenville Utilities Commission to restructure the billing agreement, implementing the lighting and HVAC schedules, applying the Low-E film to windows, and ensuring that the loading doors are kept closed when not in use. Most importantly the coding completion of the BMS is crucial to the following recommendations success



The Benefits of Pollution Prevention

Pollution Prevention (P2), also known as "source reduction," is any practice that reduces, eliminates, or prevents the creation of pollution and its release into the environment or a waste stream prior to recycling, treatment, or disposal.

- Strengthens Facility Finances**
 - Often yields **cost-effective** changes in raw material, resource, and energy use.
 - Reduces generation of chemical waste** and costs of control, treatment, and disposal.
 - Decreases operating, regulatory, and liability costs **strengthening economic growth**.
- Protects Surrounding Community Environment and Health**
 - Conserves and protects **natural resources**.
 - Reduces potential hazards to **employees, communities, and consumers**.
 - Improves public perception and enhances partnership **with the surrounding community**.

Section 5: Total Savings

Total Implementation Costs (\$)	Total kW Saved	Total Annual Savings (\$)	Total CO2 Diverted (lbs)
\$135,486	2,333,858.9	\$288719.8	3,594,441

566 tons of waste recycled instead of landfilled ? 

References

<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>



PLANT PENETRATIONS – HEAT LOSS



PAINT BURN-OFF OVEN INSULATION



AR No.:	Description	Average Implementation Cost (\$)	Average Annual Savings (\$)	Simple Payback Period (years)
12	Natural Gas Consumption	\$53,200.00	\$23,542.20	2.25

Air Compressor Demand Projects - 2024

- 97 Air Leaks Identified and repaired during summer of 2024
 - Annual Savings of \$107,000 (619 tons of CO2 emissions avoided)
 - Allowed us to reduce operating pressure of system, an additional \$70,000/year savings (239 tons of CO2 emissions avoided)



Fixes	Cost Estimate	Average Annual Savings (in \$)	Simple Payback Period	Tons of CO2 avoided
Replace regulators	\$4324.59	\$22535.88	2.3 months	129.4
Fix O rings / couplings	\$10	\$78203.83	1.12 hours	448.9
Other	Variable	\$7087.49	variable	40.7

Earth Day (ALL MONTH) Contest – Leak Identification!

Did you know??

Last year during summer shutdown **97 air leaks** were identified and fixed?

Fixing these 97 air leaks saved the Greenville Plant a total of \$170,000 in utility costs!
\$\$\$ **These savings were added into our profit sharing** \$\$\$

Contest Details-

Every verified leak that you find, tag, and put the bottom off the tag in the hopper in the cafeteria will count as an entry into the Earth Month contest.

How can I participate??

If you identify a leak in the plant (compressed air, oil, water, etc.), get the blank tags from your AC2, use a zip tie or other means to attach the top portion of the tag at the spot where it seems to be leaking

Make sure to fill out your name on the top and bottom portions of the tag in the “Leak Identified By” section

Tear off the bottom portion of the tag and place it in the hopper in the cafeteria (where customer of the month normally goes)

Maintenance will follow-up on the tags, verify that it was a valid leak, and fix it! The savings will pile up and less energy usage is good for planet earth!

Two pink 'LEAK TAG' forms. The first form is filled out with handwritten information: '0001' at the top, 'Severity: [] Mild [] Moderate [] Heavy', 'Type: [] Compressed Air [] Water [] Oil [] Other', 'Leak Identified by: Stephen Kelly', 'Date: 4/11/2025', 'Phone: 252 421 5343', 'Repair Assigned to: []', 'Cost of leak yearly: []', 'RETURN TO APPROPRIATE FACILITY/MAINTENANCE MANAGER OR LEAK TAG INFO BOARD', and '0001' at the bottom. The second form is a duplicate of the first, showing the 'INSTRUCTIONS' section on the reverse side.

Earth Day (ALL MONTH) Contest – Leak Identification!

Congratulations to our Earth Month Contest Winners!



Fixing these leaks is making a big difference in our energy demands!

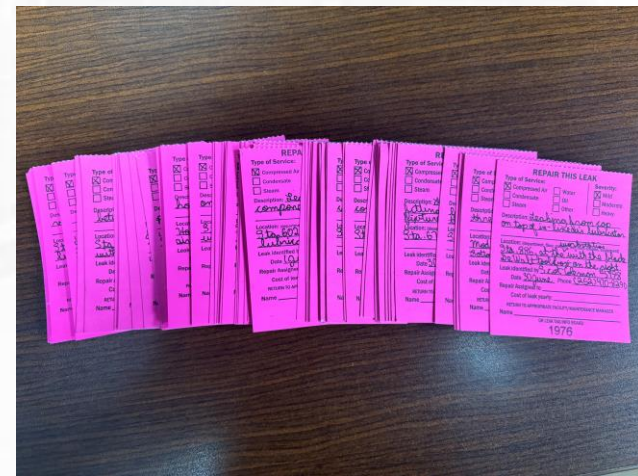
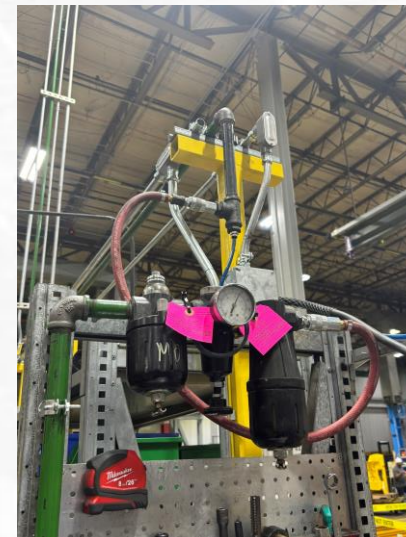
You identified and maintenance fixed 39 leaks over our contest in the month of April! We estimate this will save the company roughly \$42,000 over a year.

Missed the contest, but still finding leaks?

These tags are available at maintenance all the time, just make sure to fill out all the details, mark the leak, and then give maintenance the bottom portion of the tag and they will get the leaks fixed

Two pink leak tags are shown. The tag on the left is a 'LEAK TAG' with a circular hole at the top. It contains a 'REPAIR THIS LEAK' form with fields for 'Type of Service' (Compressed Air, Condensate, Steam), 'Severity' (Mild, Moderate, Heavy), 'Location', 'Leak identified by', 'Date', 'Leak repaired by', and 'Date'. The tag on the right is an 'INSTRUCTIONS' tag with a circular hole at the top. It contains instructions for the tag originator, including separating the tag and attaching the top portion to a visible location, filling out the bottom portion, and returning it to the appropriate facility/maintenance manager or leak tag info board. Both tags have a tag number '0001' and a date '4/11/2025'.

2025 Summer Shutdown- Compressor Support



Pollution Prevention 2024 Project Results

Household Electricity

858 tons of CO2 would be equivalent to the electricity consumption of approximately 558 households for a year.



Driving

858 tons of CO2 would be the equivalent of driving a gasoline car for approximately 4,290,000 miles... You could circumnavigate the earth 172 times at the equator

Questions

THANK YOU



HYSTER-YALE
MATERIALS HANDLING

Pollution Project Results – NOTES SLIDE

Total Leaks identified by non-maintenance personnel (and fixed) over last year = 225

During normal operation, business uses 580 CFM of compressed air

Usage when plant was not operating, worked out to 360 CFM, which over the course of a year worked out to 189,000,000 Cubic Feet of air lost through leaks

1,387,840 kWh of energy, working out to \$107,827 in annual electric costs

By fixing the leaks, we avoided 619 tons of CO2 emissions

Operating pressure reductions:

- Able to lower our plant operating pressure from 116psi, to 105 psi
- Savings of 766,022 kWh per year
- Additional 239 tons of CO2 emissions avoided