1. Application Cover Sheet (Attachment A)

Public Service Commission of Wisconsin
Office of Energy Innovation
Energy Innovation Grant Program
ATTACHMENT A - Application Cover Sheet

SECTION I - Provide information summarizing the project proposal.			
Project Title:	**Foremost Farms USA Appleton Cheese Plant Refrigeration Optimization**		
PSC Grant Request ($):	**Applicant Cost Share ($):**	**Project Total ($):**	
$200,000	**$226,400**	**$426,400**	
Choose one Eligible Activity			
☐ Renewable Energy & Energy Storage	☒ Energy Efficiency & Demand Response	☐ Electric & RNG Vehicles & Infrastructure	☐ Comprehensive Energy Planning
Acknowledgement of ARRA Applicability. Check all that apply. (see Section 1.3 of Application Instructions)			
☐ Buy American: Project: Alteration, maintenance or repair of a public building or public work.			
☒ Davis Bacon and Related Acts: Use of laborers or mechanics employed by contractors and subcontractors.			
☐ Historic Preservation: Project involves historical (over 50 years old), archeological or cultural resources.			
☐ National Environmental Policy Act (NEPA): Project activity is NOT covered by the list shown in Section 1.3.3.			

SECTION II - Provide information for your organization, signatory, and primary contact for the project.				
Applicant Type:	☐ City	☐ Village	☐ Town	☐ County
☐ Tribal Nation	☒ Manufacturer			☐ K-12 School District
☐ University of Wisconsin System	☐ Wisconsin Technical College System			☐ 501(c)(3) nonprofit
☐ Municipal Utility (water, wastewater, electric, natural gas)		☐ Hospital (public or nonprofit)		

Name (on W-9)**:**	Foremost Farms USA		
Address (on W-9)**:**	E10889 Penny Lane Baraboo, WI 53913		
County or Counties Served by Project:	Outagamie County		
DUNS Number or CAGE Code:	DUNS: 87-754-9923		
NAICS Code:	311513		
Authorized Representative/Signatory (Person authorized to submit applications and sign contracts)		**Primary Contact** (if different from Authorized Representative)	
Name:	**Mark Mueller**	**Name:**	
Title:	**Appleton Cheese Plant Superintendent**	**Title:**	
Phone:	**920-996-2708**	**Phone:**	
E-mail:	Mark.Mueller@foremostfarms.com	**E-mail:**	
Signature of the Authorized Representative			

2. Application Budget Sheet (Attachment B)

Foremost Farms USA
Refrigeration Optimization

Summary of Project Budget				
Line	Description	PSC Grant Request	Applicant Cost Shar	Total Project Cost
1	Personnel		$20,400	$20,400
2	Fringe			$0
3	Equipment			$0
4	Supplies			$0
5	Travel			$0
6	Contractual	$200,000	$206,000	$406,000
7	Other			$0
8	Indirect			$0
	Totals	$200,000	$226,400	$426,400
	% of Total	**47%**	**53%**	

3. Application Executive Summary

Foremost Farms USA (Foremost Farms) is a milk solids processing business, owned by dairy farm families who supply the milk. We process more than 6 billion pounds of milk per year to manufacture cheese, dairy ingredients, butter, and other products for various markets and applications. Foremost Farms was formed in 1995 with the consolidation of Wisconsin Dairy Cooperative and Golden Guernsey Cooperative. Today, we operate 11 plants in the Midwest and have 1,100 dairy farmer members in seven upper Midwestern states.

Grant funding from the Public Service Commission (PSC) of Wisconsin will enable Foremost Farms to launch a capital investment project to optimize the efficiency of the ammonia refrigeration system at our Appleton, Wisconsin cheese plant with the following actions:

- Splitting the single refrigeration system to allow for two temperature controls
- Implementing energy efficiency controls including compressor sequencing, variable speed controls, evaporator fan cycle control, and condenser defrost controls
- Implementing high-efficiency cooling systems
- Increasing heat exchanger surface areas
- Implementing liquid subcooling (economizing)

Combined, the proposed project will deliver a 17 percent reduction in electric use, saving 2,400 MWh and $200,000 annually in electric utility cost.

3.1 Project Description

Foremost Farms' Appleton cheese plant opened in 1995 and since then has undertaken several building additions and production expansions. As with many of these types of expansions in manufacturing, the focus of these projects had been on physical expansion and infrastructure areas, such as the refrigeration system. When this system was expanded, additional capacity was added but there wasn't a focus on integrating new equipment efficiently into the system as a whole. Since the original refrigeration system's design, capacity has more than doubled. The grant we are seeking will support a project to take a holistic approach to the system's design and implement the appropriate changes necessary to operate more efficiently and maximize the refrigeration system's capacity.

The Appleton cheese plant's refrigeration system has 2,300 tons of compressor capacity and an excess of cooling tower capacity. This refrigeration system consumes an estimated 13,000 MWh that costs more than $1.2 M in electric utility expenses annually. Currently, there are 1,300 tons of cooling loaded on the system and a planned expansion in 2021 will bring an additional 500 tons load online.

With this Refrigeration Optimization project, we will:

- Install multiple temperature functionality
  Our current refrigeration system must operate to meet the set point of the lowest temperature demand: the temperature requirement for the brine system. At our Appleton plant, less than 25 percent of the base load is needed for the brine system, with the majority of the remaining load needing a significantly higher temperature. Separating functions to two temperature systems will allow most of the compressor's work to operate more efficiently and effectively increase the refrigeration system's overall capacity.

- **Implement variable speed controls**
  Installing variable speed controls on the condenser fan motors and compressor pumps will allow for increased operational efficiency for part-load applications. Condenser fans can be slowed down to meet a needed set point, instead of running full speed when not required. The compressors currently utilize a slide valve and inlet throttling as a control for part loads, but variable speed controls are much more energy efficient.
- **Install compressor sequencing controls**
  Refrigeration compressors are currently brought on-and off-line manually based on the plant operator's estimate of required refrigeration demand. Actual refrigeration demand has multiple variables, including the outside air wet bulb temperature and current production capacity, which change rapidly. A computer controller will react better to real-time conditions and bring the appropriate mix of equipment online as needed and minimize inefficient part-load equipment operation.
- **Install additional heat exchange surface area**
  In the brine cooling system, a heat exchanger's capacity is limited by its surface area, requiring the ammonia refrigeration plant to deliver coolant at a lower temperature. Increasing the surface area of these heat exchangers will allow for increased ammonia suction temperature and higher efficiency operation.
- **Increasing the set point of refrigerated production and warehouse spaces**
  With added multiple temperature functionality, it will be possible to increase refrigerated production and warehouse areas from 28°F to 35°F and achieve greater efficiency and capacity at the refrigeration plant. These spaces currently operate at the lower temperature (28°F) and there is no benefit to change this set point, because changing this set point would yield only minimal energy savings with the current single temperature system.
- **Install economizing functionality to the system**
  When economizing functionality is implemented, flash gas is reduced on the low side and re-introduced into the compression cycle at a higher pressure through a specific "economizer" tap on the screw compressor itself. This process requires a heat exchanger, accompanying control valves, and refrigerant piping. We will order economizer kits from the manufacturer, Vilter, and retrofit screw compressors in our Appleton facility.
- **Install evaporator fan controls**
  Existing evaporator fans run continuously; with controls, we can either slow the fans down, if capable, or cycle them when the space temperature set point is satisfied.
- **Install defrost controls**
  The existing system runs a timed defrost cycle. Updated controls and sensors will allow the defrost cycle on the evaporators to terminate when the coils are clear of frost and ice and not add extra defrost heat into the refrigerated spaces.

3.2 Key Partners and Stakeholders

Foremost Farms has been developing this project for the past year. During this time, we have developed a high-level project concept within our internal energy team, which is a collaborative effort between Foremost Farms, Focus on Energy, and our utility partner, We Energies. In 2020, Golden Industrial Refrigeration was commissioned to formally study our refrigeration system and develop an executable design concept for energy efficient operations, and Bassett Mechanical will execute the design, as shown in the following table.

Organization	Contact & Role	Responsibilities
Foremost Farms USA.	Mark Mueller Appleton Plant Superintendent	Will provide internal project management, facilities engineering support, and production scheduling coordination required to execute the project.
Golden Industrial Refrigeration, LLC (GIR)	Phillip J Golden, PE President	An engineering firm specializing in the design of ammonia refrigeration systems for industrial clients. Provided a technical study and design concept (supplied as Appendix B) and will support project implementation.
Bassett Mechanical	Jim Wedemeyer Project Manager	Will provide a detailed turn-key design utilizing GIR's design concept and will also install the project.
Focus on Energy	Bill Lumsden Energy Advisor	Will calculate project energy savings using methods described in the *Wisconsin Focus on Energy 2020 Technical Reference Manual*. Will also provide financial incentives to support the project's implementation

3.3 Project Objectives and Metrics

Foremost Farms has developed and commits to delivering the following objectives and metrics.

Objective	Metrics	Measurement
Electric Energy Conservation	Save 2,400 MWh of electricity by retrofitting improved controls and capital equipment	Savings will be calculated by Focus on Energy using methods consistent with the PSC of Wisconsin's *Wisconsin Focus on Energy 2020 Technical Reference Manual*. Savings will be verified using the refrigeration system's existing controls package that is capable of trending operational points.
Project Execution	Deliver project on time and within budget	Project management and invoicing.

3.4 Reference Materials List

We provide the following reference materials for the PSC's review.

- Appendix A: Letter of Support from Focus on Energy
- Appendix B: Technical Assessment Report from Golden Industrial Refrigeration, LLC
- Appendix C: Energy Savings and Incentive Calculations from Focus on Energy
- Appendix D: Focus on Energy's Energy Efficiency Excellence Award to Foremost Farms, 2020

4. Application Narrative and Merit Review Criteria

4.1 Eligibility and Ability to Achieve the Objectives

Foremost Farms is a conforming manufacturer as defined by Wis. Stat. § 77.51(7h) and is verifiable through our company's DUNS number (87-754-9923) and NAICS 311513. This grant request falls under the PSC/OEI Energy Innovation Grant Program's activity 2: Energy Efficiency and Demand Response. Furthermore, we acknowledge the applicability of the American Recovery and Reinvestment Act (ARRA) to this project and confirm our ability to meet ARRA requirements, as follows:

- **Buy American Provisions.** The Refrigeration Optimization project is not using materials for a public building or public works project, and the Buy American Provisions do not apply.
- **Davis-Bacon and Related Acts (DBRA).** Foremost Farms and its proposed mechanical contractor, Bassett Mechanical, will comply with DBRA requirements and use at minimum prevailing wages.
- **Historic Preservation.** This project will be implemented at Foremost Farms' Appleton cheese plant located at 1815 West Spencer St. in Appleton, Wisconsin, a facility that is not subject to historic preservation requirements.
- **National Environmental Policy Act (NEPA).** This project will implement energy efficient equipment in an existing building, a NEPA bounded category, rendering the project excluded from further NEPA review. Foremost Farms will complete an Environmental Questionnaire if this is deemed a requirement at a later date.

A longstanding Wisconsin cooperative, Foremost Farms offers proven business success since we first established our business in 1995. We are committed to being a good citizen of both our local and global communities. In partnership with our member–owners, we focus on continuous improvement activities and constantly work toward finding new, more sustainable resources; more efficient technology; and developing new processes for our dairy plants. Our dairy plants handle more than 6 billion pounds of milk annually, which requires that we maintain and administer strict operational processes and guidelines to ensure the safety of the food products we produce and sustained health of our business. To this end, our plant superintendent Mark Mueller is committed to making this project a success and will have direct access to our senior management for support as needed.

Team partner Bassett Mechanical, a well-respected industrial refrigeration firm, will deliver this project. Headquartered in Kaukauna, Wisconsin, Bassett Mechanical is a third-generation family business that has provided refrigeration services since 1936; they bring the capability and experience to successfully deliver a high-quality project. Additionally, they have in-depth knowledge and experience with our Appleton plant's ammonia refrigeration system—since they designed the original system and have maintained it since 1995.

4.2 Budget Justification and Cost Share ("Match")

Foremost Farms seeks a grant of $200,000 from the PSC. With project implementation costs totaling more than $400,000, the project's upfront expense is cost prohibitive, even considering annual electricity savings. As so many other organizations, we will have a very tight capital budget this year with limited discretionary funds for projects that are not already in the capital budget. Without grant funding to help offset implementation costs, this project will be deferred until more

cash flow becomes available to utilize, likely beyond 2021. We present how funding will be allocated in the following table.

Budget Line Item	Description/Justification	Amount
1.	**Personnel**	
	Project Manager – Foremost Farms – 120 hrs. @ $95/hr.	$11,400.00
	Maintenance Staff – Foremost Farms – 120 hrs. @ $75/hr.	$9,000.00
2.	**Fringe**	
	N/A	$0.00
3.	**Equipment**	
	N/A	$0.00
4.	Supplies	
	N/A	$0.00
5.	Travel	
	N/A	$0.00
6.	Contractual	
	Thermosyphon oil cooling	$40,000.00
	Economizing controls	$50,000.00
	Condenser fan control (VFD) and sequencing controls	$4,000.00
	Brine heat exchanger— increase surface area	$50,000.00
	Two temperature levels	$250,000.00
	Freezer to Cooler operation programming	$1,000.00
	Fan cycling controls/programming	$3,000.00
	Defrost termination controls	$8,000.00
7.	Other	
	N/A	$0.00
8.	Indirect	
	N/A	$0.00
9.	Cost Share	
	Focus on Energy Grant	$133,000.00[1]

[1] We have supplied a preliminary incentives estimate from Focus on Energy in Appendix C.

4.3 Savings and Payback

This project will deliver 2,400 MWh of energy savings and electric utility bill decreases of $200,000 annually. In addition, this project will increase the ammonia refrigeration system's capacity by 500 tons from energy efficiency gains alone. This increased capacity will enable future production growth without our needing to increase refrigeration capacity. By increasing the refrigeration system capacity, the Appleton plant will be in a better position for future line expansions and greater production volume, since this additional capacity allows for relatively low-cost production increases when compared to other cheese plants within our organization.

We calculated the expected payback for this project using a simple payback method:

$$Simple\ Pauback = \frac{Capital\ Investment}{Utility\ Savings}$$

The project's payback, not considering any grant support from the PSC/OEI or Focus on Energy, is two years; however, this is too long of a payback for Foremost Farms to implement this project. Applying Focus on Energy Business Program Incentives and Energy Innovation Grant, the payback period will be less than one year, which will make it financially feasible for us to implement the project in 2021. Without the Focus on Energy grant and the Energy Innovation Grant, this project will be deferred by Foremost Farms' executive team indefinitely.

4.4 Energy Savings and Environmental Impact

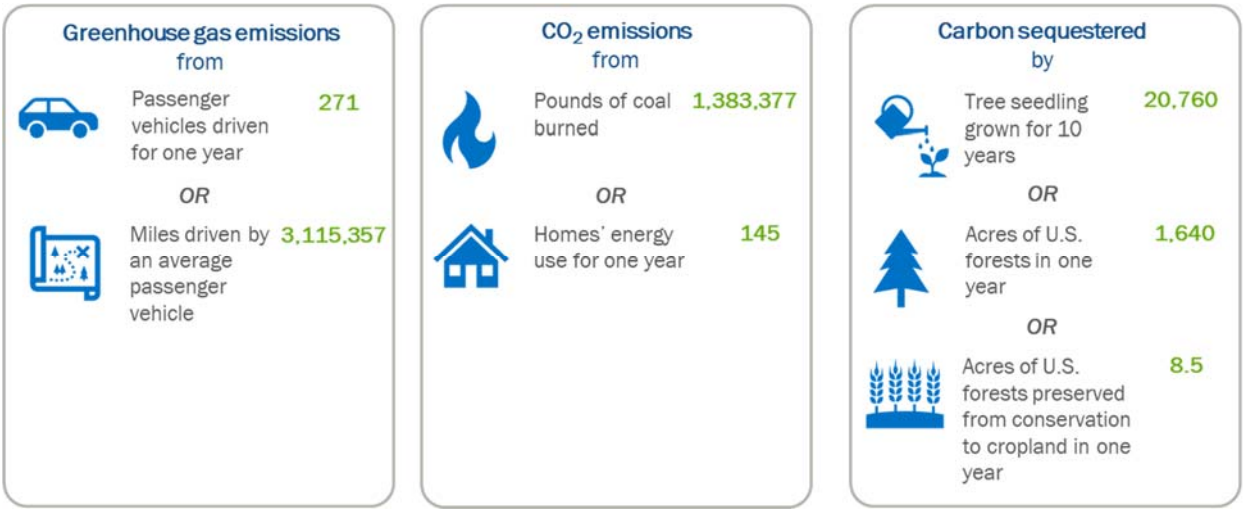
For emissions savings, we used the U.S. Environmental Protection Agency's Greenhouse Gas Equivalencies Calculator. Delivery of this project will provide important environmental benefits, as shown in the following two graphics.

Projected Emission Reductions Based on Energy Reduced

	CO_2 (MT)	CH_4 (kg)	N_2O (kg)
Electricity (kWh)	1,247	125	18
Totals	1,247	125	18

*Data from EPA Simplified GHG Emissions Calculator

This shows another tangible way to consider the project's environmental benefits.



4.5 Equity and Energy Justice

Foremost Farms is committed to and very engaged in being a good corporate citizen to both our local and global communities. Because we understand that farming is in itself a resource dependent and intensive industry, we seek to find more sustainable resources and efficient technology and to develop new processes for our dairy plants that reduce our overall footprint and give back to the communities in which we live and work. Some of our accomplishments and efforts include:

- Being recognized by Wisconsin's Focus on Energy for innovative processing techniques that save energy and water and reduce emissions (materials are provided in Appendix D). We also use nationally recognized tools from Field to Market, Innovative Center for U.S. Dairy, National F.A.R.M. Program, and other in-state tools to measure our sustainability and environmental results.
- Proudly adopting the U.S. Dairy Stewardship Commitment, which affirms to our customers, our consumers, and the global marketplace our pledge to responsible dairy production as we nourish the communities we serve. We join other dairy cooperatives and companies around the country in assuring best practices in important areas like animal care, the environment, and food safety. Our complex manufacturing process requires the support of many local suppliers and businesses, and we seek to produce our products as efficiently and eco-friendly as possible.
- Working to combat global warming and other environmental issues that put farming at risk. We strongly believe in running our operations as energy and water efficient as possible to protect our farms and food security. Implementing this energy efficient project will significantly reduce our carbon footprint.
- Being a proud partner of the Dairy Strong Sustainability Alliance— a diverse group of partners who ensure that production of dairy foods and environmental practices continuously improve. We were the first dairy processor to join the Alliance in 2016, and we continue to aggregate more data each year, both from our farms and processing facilities.
- Being recognized by the Wisconsin Sustainable Business Council for seven years as a Green Professional as part of the Green Masters Program, which is an assessment that recognizes and benchmarks sustainability initiatives.
- Supporting local communities and agricultural organizations. We give back more than $350,000 annually to local organizations and events that are important to our employees and our member–owners. Much of this goes to support hospitals, fire departments, and emergency responders in communities where we have facilities. Every year, Foremost Farms awards $3,000 scholarships to members and their children who are pursuing a career in agriculture.

At Foremost Farms, we support our local business and are committed to hiring local employees and contractors. Many of our facilities are in economically fragile communities and we adopt the responsibility to be community partners and provide living wage jobs with growth opportunities to our communities.

4.6 Financial Leverage and Economic Impact

At its core, this project will deliver 2,400 MWh of annual energy savings, lower our electric utility bill by $200,000 per year, and increase our refrigeration capacity by 500 tons. Given the present economic downturn and our limited capital budget availability, this project cannot be implemented in 2021, or any time in the foreseeable future, without outside financial support such as Focus on Energy incentive and an Energy Innovation Grant. An investment of $400,000 is simply not available

for this project; however, outside financial support and a short payback period will enable us to adopt the project this year.

Aside from energy and cost savings, this project offers other benefits from investing in the Appleton plant's infrastructure, including enabling the plant to increase cheese production since refrigeration is a bottleneck in our production process. The investment will also decrease production costs (dollar per pound) and place us in a more economically stable position, which is better for our member farmers and local communities. Lower production costs will allow us to better absorb market fluctuations and improve opportunities to grow in the market, which offers added protection for Wisconsin jobs.

4.7 Existing Energy Planning Efforts

Foremost Farm has an extensive track record of implementing energy efficiency projects. As recently as 2020, Foremost Farms' Appleton cheese plant received Focus on Energy's Energy Efficiency Excellence Award, which was formally presented to us by Focus on Energy and PSC Commissioner, Tyler Huebner. Since 2018, we've had an energy team, which includes staff from Foremost Farms and energy advisors from both Focus on Energy and our utility partner We Energies, that has met monthly. This team has implemented energy efficiency projects that have saved our Appleton facility more than 1,000 MWh and 20,000 therms annually and nearly $100,000 per year in utility bill savings. The team has completed four energy assessments identifying more than 25 energy efficiency opportunities, of which we have completed 11 projects, including:

- Lighting improvements
- Steam and compressed air system leak identification and repair
- Compressed air system blower and electrical replacements
- No-loss condensate drain installation
- Variable speed drive installations on process pumps

With the support of this engaged energy team, Foremost Farms has been able to deliver on and advance our commitment to energy management and efficiency, with quantifiable results as well as behavioral and cultural changes within our organization. For example, our facility in Plover has been recognized as ISO 50001 Ready by the U.S. Department of Energy for establishing business practices around energy. We intend on extending this certification to our other manufacturing facilities.

We also have developed, in collaboration with Schreiber Foods, Richland Center Renewable Energy (RCRE), a state-of the art wastewater treatment facility located in Richland Center, Wisconsin. In 2019, the team at RCRE completed a project to get the plant's industrial sludge reclassified from sludge to fertilizer—a big win since industrial sludge from our processing plant can now be recycled and applied as land spread, instead of diverting it to landfills. In two months alone, 41 loads of fertilizer were distributed and spread onto farm land, which otherwise would have gone to landfills.

4.8 Energy Resiliency

Through energy efficiency gains, this optimization project will reduce power demand at our Appleton plant by nearly 400 kW. As a primary utility customer, Foremost Farms owns and operates the substations and electrical infrastructure. Decreasing our facility's power requirements will exert less stress on the electrical system to lessen the risk of failure and open capacity on the electrical system for future growth and expansion.

This project will also deliver an additional 500 tons of cooling capacity to the ammonia refrigeration system. Similar to the electrical system, the refrigeration system will run at a lower load, placing less stress on the system. This additional capacity also offers the benefit of effectively adding redundancy to the refrigeration system. Since the refrigeration system will have extra capacity and multiple compressors and cooling towers, if a critical piece of equipment fails or needs to be pulled off line for repair or maintenance, the remaining equipment will be able to handle refrigeration demand and production will not be interrupted.

4.9 Education and Awareness

The refrigeration optimization project will deliver a variety of new operational control options and sequences, many of which were not available when the original system was installed. During this project's development, we commissioned Golden Industrial Refrigeration, a refrigeration expert, to analyze our current system and its operation. Their expertise and analysis approach afforded us a great learning opportunity to better understand how our existing refrigeration system operates and how to operate it more efficiently via capital upgrades.

Most of this optimization project involves implementing new controls that will allow the system to run more efficiently. These new controls will need to be programmed, which will unlock employee training opportunities to increase equipment operators' knowledge and skills. These new controls will also provide additional measurement points that can be trended and reported, affording us opportunities to identify changes in refrigeration system performance and performance issues as they arise for better internal capabilities in future. Creating the ability to report energy usage simply will lead to an environment where refrigeration energy consumption can be used as an operational KPI.

4.10 Innovation

Our proposed system design takes an innovative approach to both energy efficiency and refrigeration system expansion. The current mindset for industrial refrigeration expansion typically is to purchase new compressors and cooling tower capacity to manage increased load. Foremost Farms' Appleton has been a great example of this mindset. With more than 25 years in operation, the refrigeration system has more than doubled in capacity since its original commissioning, and our approach has been to look to new equipment to address capacity issue.

Concepts such as retro-commissioning or recommissioning building systems and operations are becoming more commonplace in our economy; however, these approaches can miss big energy efficiency opportunities since they focus only on resetting the systems back to their original design concepts. Here, we are taking an innovative approach to completely redesign our system and controls to maximize its operational efficiency. The overall thermodynamic performance of ammonia compressors and cooling towers has not improved significantly over the past few decades, but controls for this type of equipment have undergone substantial innovation. Fitting older, well-maintained equipment with modern controls is a great way to cost-effectively improve a refrigeration systems' efficiency. With this project, we'll continue to utilize existing equipment, which still has a long useful life, but control the system so that its efficiency matches the world-class performance of new equipment.

5. Reference Materials

5.1 Appendix A: Letter of Support from Focus on Energy

5.2 Appendix B: Technical Assessment Report from Golden Industrial Refrigeration, LLC

5.3 Appendix C: Energy Savings and Incentive Calculations from Focus on Energy

5.4 Appendix D: Focus on Energy's Energy Efficiency Excellence Award to Foremost Farms, 2020

5.1 Appendix A: Letter of Support from Focus on Energy

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Partnering with Wisconsin utilities

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focusinfo@focusonenergy.com
www.focusonenergy.com

January 20, 2021

Public Service Commission of Wisconsin
Office of Energy Innovation
Energy Innovation Grant Program

Re: Letter of Support for Foremost Farms' Energy Innovation Grant Application

The Focus on Energy Business Program is pleased to provide this letter of support for Foremost Farms' Energy Innovation Grant application.

Based on our understanding of the project, Focus on Energy estimates the refrigeration system upgrade being considered by Foremost Farms' is eligible for a custom incentive of $133,149. This is a preliminary estimate. The actual incentive depends on final detailed project design and requires Focus on Energy pre-approval prior to the project getting underway.

Foremost Farms has been an active participant in the Focus on Energy program. In the last three years the Appleton facility has utilized nearly $21,000 in incentives from Focus on Energy for improving the energy efficiency of their lighting, compressed air and steam systems.

We applaud Foremost Farms' energy efficiency efforts and fully support their application to the Energy Innovation Grant Program.

Sincerely,

Nate Altfeather, Manager
Large Industrial Offering
Focus on Energy Business Programs

5.2 Appendix B: Technical Assessment Report from Golden Industrial Refrigeration, LLC

Golden
Industrial
Refrigeration

January 7, 2021

Foremost Farms
1815 W. Spencer Street
Appleton, WI 54914
ATTN: Mr. Mark Mueller

Dear Mark:

Attached is a Technical Assessment of the central ammonia system at your facility. There are a number of options which will greatly improve energy efficiency of ammonia refrigeration system for many decades to come. Energy savings can be achieved by incorporating:

- Thermosyphon oil cooling (vs. liquid injection)
- Economizing
- Optimize compressor sequencing
- Optimize condenser fan sequencing
- Increased brine heat transfer surface area
- Two vs one temperature level (dedicated brine chilling)
- Operating 28 deg-f freezer as a 35 deg-f cooler
- Cycling evaporator fans
- Intelligent defrost termination
- Variable speed compressor
- Intelligent head-pressure control
- Hot water heating (via industrial-grade heat pump)
- Automatic light control
- LED lighting
- Premium efficiency motors

Please review the attached executive summary, Technical Assessment report and supporting documentation. If you have any questions, please feel free to contact us.

Sincerely,

Philip J. Golden P.E.
Golden Industrial Refrigeration, LLC

Golden Industrial Refrigeration

EXECUTIVE SUMMARY-

This central ammonia system has numerous opportunities to enhance energy efficiency. Central refrigeration plants are a large consumer of electrical energy and is the single greatest electrical energy user at this plant. Some of the recommended modifications below, such as EEO-2, 5, 6 and 7 are base improvements to the refrigeration cycle. They represent permanent efficiency improvements for the life of system. Other energy efficiency improvements are controls related and can be achieved by optimizing efficiency of existing equipment with supplemental controls, devices and re-programming.

Although the ammonia system's house suction pressure operates at 20 psig (6 deg-f), the lowest temperature load requirement is the cube and shred brine systems each with an outlet set point of +/-15 deg-f. This brine load dictates house suction and yet it only account for about 76 tons of the systems base refrigeration load of approximately 700 tons. In summer (due to the Make-Up Air Units) peak refrigeration load exceeds 1,300 tons. As the saying goes "the tail is wagging the dog". Most of the plant's refrigeration loads are back-pressure regulated to 45-50 psig, therefore they do not need to operate at 20 psig. It is prudent to consider splitting this system to a two-temperature level system.

It has been determined there is adequate compressor capacity. There is over 900 tons of back-up compressor capacity. There is 11% excess evaporative condensing capacity based on connected compressor load, however, maximum actual operating compressor indicates there is 34% excess capacity.

The greatest efficiency improvement at this plant is to methodically raise suction pressure by implementing EEO-5 thru 7. There may be bottlenecks discovered that need to be rectified.

Condenser fan control (EEO-4) is also a great opportunity to reduce the parasitic loads of fan power by utilizing the full surface area of condensers and controlling fan speed to take advantage of basic fan laws. Priorities of implementation are assigned to each EEO.

EEO	Priority	Description	KWH/yr	KW	$/yr	Budget Cost	Pay Back
1	10	Thermosyphon oil cooling	124,022	14.2	10,343	40,000	3.9
2	6	Economizing	175,397	46	14,522	50,000	3.4
3	2	Compressor sequencing	TBV	TBV	TBV	2,000	TBV
4	1	Condenser fan control (VFD)	325,722	50	30,136	2,000	.1
5	5	Brine surface area	215,017	33.9	19,136	50,000	2.6
6	3	Two temperature levels	822,421	137	73,196	250,000	3.4
7	4	Freezer to Cooler operation	646,188	108	57,511	1000	.1
8	7	Fan cycling	19,458	0	1,732	3,000	1.7
9	8	Defrost termination	27,757	0	2,470	8,000	3.2
10	9	Variable Speed compressor	TBV	TBV	TBV	TBV	TBV

FACILITY DESCRIPTION-

This is a cheese production plant with a twenty four hour, seven day per week operation. There is a combination of direct and indirect refrigeration loads for sweet water chilling (whey, starter vats, blend tanks) milk intake silos, brine chilling, make-up air units for production rooms and a 28 deg-f freezer. Many of the refrigeration loads are back-pressure regulated to 45 psig or more to prevent freeze-up in milk silos, freeze up of secondary fluids (sweet water) and make-up air units' flooded ammonia coils. Analysis of refrigeration load (based on compressor operation) reveals a baseline refrigeration load of about 700 tons (+/-). Central plant refrigeration load climbs to 1,300 tons + in summer, when make-up air units are operating at or near design ambient conditions. An annual load profile was generated and can be found in the attached supporting documentation. Of the 700 ton base load, only about 180 tons is considered a "low temp" load. This is the load associated with generating chilled brine for block, shred and cube flumes. Other refrigeration loads are operating at 30 deg-f or higher.

REFRIGERATION SYSTEM-

This central ammonia system has a combination of five screw compressors and one reciprocating compressor. Screw compressors are a combination of liquid injection oil cooling (LIOC) and thermosiphon oil cooling (TSOC). Total installed capacity of ammonia compressors is 2320 tons (6 deg-f SST). System operates as a single-temperature plant running typically at 20 psig. The liquid re-circulation package supplies direct refrigerant to: all cooler evaporators and milk intake silos. All other refrigeration loads such as: MUAU's, sweet water chiller and brine chiller have flooded ammonia coils with integral surge drums. There are three (3) evaporative condensers with a catalog rating of 42,036 MBH (THOR) (@ 78 deg-f WB and 95 deg-f SCT) to accommodate the 27,764 MBH (THOR) of combined compressor capacity (operating at full load). There is 34% excess condenser capacity relative to the 5 of 6 compressors expected to operate. All condensers have variable-speed fans. There is a Central PLC developed and installed by Bassett Mechanical. Cheese freezer has two evaporators to maintain a temperature of 28 deg-f. Freezer evaporators have hot gas defrost. Evaporators are controlled by the central programmable control system. The PLC sequences condenser fans, fan speed, remote sump pumps, compressor sequencing, temperature control of freezer and defrost sequencing for its evaporators. Nearly all piping for this system is located above the roof.

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EEO-1 COMPRESSOR OIL COOLING

A fairly common and inexpensive form of compressor oil cooling for ammonia screw compressors is to use liquid refrigerant. Although there is a thermosiphon system installed, the two (2) 900 hp Vilter screw compressors are piped with liquid-injection oil cooling. Liquid refrigerant is injected into the compressor casing to cool the oil. This form of oil cooling does impart a power penalty on the compressor (2.5%). Other forms of oil cooling involve externally absorbing and rejecting heat from the oil. This can be in the form of water, glycol or refrigerant. Water or glycol cooling requires an external pump to circulate liquid to a cooling tower or fluid cooler. An essentially free form of oil cooling is to use liquid refrigerant in a fluid/fluid heat exchanger. This type of cooling is called thermosyphon cooling in that it requires no mechanical pumps to achieve heat rejection. Liquid injection oil cooling requires small-bore pipe and some controls, whereas thermosyphon oil cooling requires heat exchangers and large-bore pipes. Thermosyphon oil cooling is more expensive to install than liquid injection oil cooling. For results below, it is assumed only one of the 900 hp screws operates at any time and when it does it is based loaded at 100%.

Reduced annual energy use	**124,022 kwh/yr**
Reduced peak power	**14.2 kw**
Reduced operated costs	**$10,343/yr ($.08/kwh avg)**
Approximate cost:	**$40,000**
Simple payback:	**3.9 years**

Recommendation:

Evaluate the thermosiphon supply and return to determine if pipe sizes are sufficient to accommodate the addition heat rejection of SC-10 & 11 under a maximum load of approximately 1500 tons.

Converting to thermosiphon oil cooling will require the following:

- Complete engineering (ammonia and oil side)
- Secure costing from qualified refrigeration contractor to complete installation.
- Evaluate payback associated with reduced operating costs and pricing.
- Procure and install two (2) plate-and-shell thermosiphon heat exchangers
- Procure oil-side components necessary for conversion (oil pump, AMOT valve, etc.)
- Tie into existing thermosiphon supply and return mains
- Complete trim piping of thermosiphon heat exchanger (oil side)
- Complete trim piping of thermosiphon heat exchanger (ammonia side)
- Pressure test all new piping and heat exchangers
- Complete all miscellaneous tasks such as paint, valve tags, pipe labels, etc.
- Retain existing liquid injection oil cooling piping and valve group for back-up
- Perform all PSM functions such as Management Of Change, Standard Operating Procedures, Update Process Safety Information, Process Hazard analysis, etc.

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EEO-2 ECONOMIZING

Economizing is a modification to the refrigeration cycle to increase its thermodynamic efficiency. Essentially, high pressure liquid feed to plant loads is chilled from condensing temperature (85 deg-f) to say 35 deg-f. Economizing is a permanent increase in system thermodynamic efficiency. When economizing is implemented, the resulting flash gas is reduced at low side and re-introduced into the compression cycle at a higher pressure through a specific "economizer" tap on the screw compressor itself. What is required are a heat exchanger, its accompanying control valves and refrigerant piping. Economizer kits can be ordered and installed on screw compressor at factory or they can be field retrofitted on an existing screw compressor. The power consumption for refrigeration drops from 1.24 TO 1.16 BHP/ton (6.5% less).

Reduced annual energy use	**573,378 kwh/yr**
Reduced peak power	**90.3 kw**
Reduced operated costs	**$47,002/yr ($.089/kwh avg)**
Approximate cost:	**$75,000**
Simple payback:	**1.6 years**

Another benefit of economizing is the reduction in flash gas to low side resulting in an increase of compressor capacity (11.1%). Note: energy savings associated with economizing or liquid sub-cooling is directly proportional to suction and discharge pressure; .i.e. a higher average suction pressure and/or lower average discharge pressure will reduce the benefit and efficiency gain of economizing.

Recommendation:

Installing liquid sub-cooling (economizing) will require the following:

- Complete engineering
- Secure costing from qualified refrigeration contractor to complete installation.
- Evaluate payback associated with reduced operating costs and pricing.
- Procure and install two (2) shell-and-tube factory-supplied economizer heat exchangers to achieve liquid sub-cooling. It is expected that both SC-10 & 11 would be retrofitted with factory supplied economizer "kits" each suitable for chilling HPL down to 1500 tons of refrigerant to 37 deg-f +/-
- Route plant's main HPL line from receiver through both SC-10 & SC-11 heat exchangers in parallel.
- Complete trim piping of economizer heat exchangers (shell and tube sides) in accordance with factory recommendations
- Pressure test all new piping and heat exchangers
- Insulate any HPL liquid lines down stream of economizers through to all flooded surge drums on roof.

- Complete all miscellaneous tasks such as paint, valve tags, pipe labels, etc.
- Perform all PSM functions such as Management Of Change, Standard Operating Procedures, Update Process Safety Information, Process Hazard analysis, etc.

EEO-3 COMPRESSOR SEQUENCING

What we did find in the analysis of control system trending data were numerous occurrences where multiple screw compressors were operating part-loaded *simultaneously*. The best solution is to develop a compressor sequencing strategy that incorporates:

1. Knowledge of each compressor's capacity
2. Part load inefficiency
3. Best sequence or mix of compressors

This last item must take into consideration operating through the range of loads from 200 tons through 1500 tons to maximize efficiency. Perhaps a PID control strategy can also be incorporated to track suction pressure over time and minimize short-cycling of compressors. The table below illustrates the capacities of all screw compressors (full and part load) that must be incorporated into a "lead/lag" scheme to minimize power consumption as plant's refrigeration load fluctuates throughout the days and weeks.

Recommendation

To quantify potential energy savings of proper sequencing, compressor loading (slide valve position) will need to be evaluated nearly on a minute-by-minute basis. This information could be extracted from historical trending via the central control system. Evaluation will be to determine:

- Duration of time compressor(s) operate part load
- How low these partly loaded compressors are operating

If it is determined there are numerous opportunities to better sequence compressors and reduce performance penalty of part-load operation the following steps should be taken:

- Re-evaluate the existing control logic for compressor sequencing
- Prepare a table of all compressors capacities and performance (BHP/ton) in 10% increments
- With assistance of a qualified technician, engineer, controls expert and plant Operators, craft a new compressor sequence from 200 tons thru 1500 tons that optimizes efficiency, but at the same time minimizes compressor short cycling.
- Re-program compressor sequencing accordingly
- Complete field evaluation of sequencing to ensure plant's refrigeration needs are satisfied and compressors are performing properly.

EEO-4 VARIABLE-SPEED CONDENSER FANS

Industry standard practice is to control discharge pressure with condenser fans that are variable speed drive. In lieu of full-speed fans, this allows condenser's capacity to match refrigeration compressor load by varying fan speed and accompanying heat rejection. Although all condensers have variable speed drives, they are not being sequenced properly to take advantage of the heat transfer surface area available. That is, it was found only one condenser would be operating at a time, and at near full speed. A more efficient approach is to operate both condensers together and at the same reduced fan speed. Utilizing the full heat transfer surface area and lower fan speed will save energy in accordance with fan laws. To incorporate this strategy may require a change in existing control system's logic and programming. Another modification may be to change the summer/winter sequence for fan and pump operation. Operating pumps as much as possible in fall, winter and spring will is an inexpensive way of controlling discharge pressure.

Reduced annual energy use	**325,722 kwh/yr**
Reduced peak power	**50 kw**
Reduced operated costs	**$30,136/yr ($.089/kwh avg)**
Approximate Cost:	**$2000**
Simple payback**:**	**0.1 years**

Recommendation

The following steps should be taken:

- Re-evaluate the existing control logic for condenser fan and pump sequencing.
- With assistance of a qualified technician, engineer, controls expert and plant Operators, craft a new condenser fan and pump sequencing strategy from 200 tons thru 1500 tons that takes full advantage of condenser heat transfer surface area with maximum efficiency gain via fan laws). Ensure this strategy minimizes fan and/or pump short cycling.
- Re-program for new condenser fan and sequencing strategy.
- Complete field evaluation of condenser fan and pump sequencing to ensure discharge pressure is steadily maintained and condenser fan VFD's are performing properly.

EEO-5 ADDITIONAL BRINE HX SURFACE AREA

This plant's single temperature ammonia system is dictated by the brine chilling requirements of cube operation. Currently, Brine supply of Cube operation is typically 330 gpm with a supply of 15 deg-f and a return of 20-22 deg-f. These parameters indicate typical cube brine load averages 76 tons. With the plant's base refrigeration load of approximately 700 tons, in this scenario the: "the tail is truly wagging the dog". There is a motorized back-pressure regulator that modulates Brine chiller surge drum pressure (to regulate evaporator temperature based on brine outlet temperature). Its current operation has central ammonia compressors running at 20 psig (6 deg-f). A 15

deg-f Brine supply temperature suggests the approach temperature (Brine outlet vs ammonia inlet temperature) could be greatly improved. Analysis below is actually based on increasing the surface area of cube brine plate-and-frame chiller to decrease approach temperature by ONLY 2 deg-f (minimum). This would allow house suction to operate at 22 psig (8 deg-f) in lieu of 6 deg-f. The performance gain is a reduction in compressor power from1.24 bhp/ton to 1.21 bhp/ton (3% reduction) for even a 2 deg-f decrease in brine chiller approach temperature.

Reduced annual energy use	**215,017 kwh/yr**
Reduced peak power	**34 kw**
Reduced operated costs	**$19,136/yr ($.089/kwh avg)**
Approximate Cost:	**$50,000**
Simple payback:	**2.6 years**

Operating VSM-2101 at 8 deg-f (22 psig) from current 6 deg-f (20 psig) will also increase its capacity from 572 tons to 600 tons or a 4.9% increase.

There are other factors that could be impacting brine chiller performance and artificially forcing an increase of approach temperature:

- Oil accumulation or fouling of plates on ammonia side
- Water build-up on low side

As these brine chillers represent the lowest temperature loads in the system, there is a possibility that water has accumulated and altered the thermodynamic characteristics of the ammonia entering flooded plates. The following diagnostic tasks are recommended:
1). Take a sample of ammonia (liquid drop leg) to quantify water content
2). Execute a complete pump down of ammonia from all brine chillers and check for the presence of water and/or oil left behind.

Recommendation
To accomplish this efficiency gain will require expanding the plate count of plate-and-frame chiller(s) for brine chilling or installing new heat exchangers. Action plan is as follows:

- Complete a detailed engineering analysis of heat exchanger(s) application (based on current brine design parameters) to determine optimum surface area necessary to achieve best approach temperature for all three brine systems.
- Complete engineering (ammonia and brine side).
- Secure costing from qualified refrigeration contractor to complete installation.
- Evaluate payback associated with reduced operating costs and pricing.
- Procure and install new or expanded plate counts on one or more brine heat exchangers.
- Complete trim piping of new (or expanded) plate and frame heat exchangers (brine and ammonia piping)

- Pressure test all new piping and heat exchangers
- Complete all miscellaneous tasks such as paint, valve tags, pipe labels, etc.
- Perform all PSM functions such as Management Of Change, Standard Operating Procedures, Update Process Safety Information, Process Hazard analysis, etc.
- Commission new low temperature side and adjust house suction pressure

EEO-6 ONE- VS. TWO- TEMPERATURE SYSTEM

This plant operates as a single temperature ammonia system. Its current operation has central ammonia compressors running at 20 psig (6 deg-f). Analysis below is actually based on operating high temperature loads at 14 deg-f in lieu of 6 deg-f. The assumption here is that piping, valves and suction trap to split off brine chilling loads has been completed and is dedicated to its own house suction of 6 deg-f. This will allow Operators to reset main house suction pressure to 27 psig (14 deg-f) (in lieu of current 6 deg-f). It is not necessary to operate the entire ammonia system at the 20 psig suction pressure as most of the plant's refrigeration loads are back-pressure regulated to 50 psig (32 deg-f) and above. These loads include: Milk silos, Sweet water chilling and Make-up air units for production and shredding rooms. The performance increase is a reduction in compressor power from 1.21 bhp/ton to 1.07 bhp/ton (11% reduction) for all the high-temperature loads.

Reduced annual energy use	**822,421 kwh/yr**
Reduced peak power	**137 kw**
Reduced operated costs	**$73,196/yr ($.089/kwh avg)**
Approximate Cost:	**$250,000**
Simple payback:	**3.4 years**

Operating VSS-2101 at 14 deg-f (27.4 psig) from 6 deg-f (20 psig) will increase their capacity from 600 tons to 693 tons or a 15% increase.
To accomplish this efficiency gain will require roof-top piping modifications, installation of a second high-temperature suction trap, transfer piping and re-piping suction lines of one or more compressors to convert them to "swing" machines. These compressors would be able to operate on high temp or low temperature suction.

As the new low temperature compressors will be dedicated to chilling brine, the inlet pressure regulator on the lowest temperature brine system could be bypassed. A new control parameter could be incorporated that "re-sets" low temperature compressor suction pressure based on brine outlet temperature. That is, in lieu of having a static 22 psig suction pressure, it could operate higher (or lower) to achieve target brine temperatures. The pressure drop (and negative impact on efficiency) of a back-pressure regulator can be eliminated.

Recommendation

Splitting this system into a two-temperature system will require the following:

- Complete engineering
- Secure costing from qualified refrigeration contractor to complete installation.
- Evaluate payback associated with reduced operating costs and pricing.
- Procure and install a new low temperature suction trap and liquid transfer system.
- Route a new low temperature brine suction main from all existing brine chiller to the new suction trap.
- Route a dry suction main from new low temperature suction trap to compressors SC-1 & SC-2.
- Complete trim piping of suction trap and transfer system
- Pressure test all new piping and vessels
- Complete all miscellaneous tasks such as paint, valve tags, pipe labels, etc.
- Perform all PSM functions such as Management Of Change, Standard Operating Procedures, Update Process Safety Information, Process Hazard analysis, etc.
- Commission system and adjust house suction pressures accordingly.

EEO-7 28 deg-f FREEZER vs 35 deg-f COOLER

In our opinion, there is no need to operate cheese cooler as a freezer (28 deg-f). More typical operation for cheese storage is 35 deg-f. Once brine loads are uncoupled from current single-temperature to a two-temperature system (EEO-5 above), the current cooler would then dictate house suction pressure. Another 7 deg-f increase from an 14 deg-f to 21 deg-f SST temperature will have an impact on high temperature suction at compressors. Evaporator capacity was evaluated against peak load in cooler. Below is the calculated load and catalog evaporator capacity. Evaporator capacity based on evaporators with a 10 deg-f TD (28 deg-f freezer and 18 deg-f coil). Calculated load includes a product load of 200,000 # day of cheese cooling from 45 deg-f to 35 deg-f.

FREEZER	LOAD	EVAPS	ID	TR/EVAP	TR	COMMENTS
1	22.5	2	EV-3 &4	12.1	24.2	

It is not necessary to install additional evaporator capacity in current freezer to achieve a 10 deg-f TD. Allowing for a 4 deg-f loss in suction piping, new house suction pressure would rise from 14 deg-f (27 psig) to 21 deg-f (34.5 psig).

Reduced annual energy use	**646,188 kwh/yr**
Reduced peak power	**108 kw**
Reduced operated costs	**$57,511/yr ($.089/kwh avg)**
Approximate Cost:	**$1,000**
Simple payback:	**.1 years**

Recommendation

To implement this EEO, the following tasks are required:

- Assess need for a 28 deg-f vs 35 deg-f cooler
- Adjust cooler temperature as high as possible (control system) and evaluate
- Adjust house suction pressure upwards incrementally until it impacts evaporator performance (below a 10 deg-f TD)

EEO-8 EVAPORATOR FAN CYCLING

It is common practice to allow evaporator fans to run continuously when not in defrost. Controls can be implemented to allow fans to cycle off when room (or zone) temperature is satisfied or drop their speed via variable frequency speed drives. To circulate air, a control strategy can be incorporated to cycle the fans on periodically to mitigate temperature stratification.

Not only is it possible to save electrical energy associated with reduced fan operation, there is a reduced heat load to the space and therefore less impact on the central ammonia plant. Compressor energy use, therefore, is also reduced.

Reduced annual energy use	**19,458 kwh/yr**
Reduced peak power	**0 kw**
Reduced operated costs	**$1,732 /yr ($.089/kwh avg)**
Approximate Cost:	**$3,000**
Simple payback:	**1.7 years**

Recommendation

To implement this EEO, the following tasks are required:

- Secure costing for wiring, devices and controls necessary to implement fan cycling on room temperature.
- Evaluate payback associated with reduced operating costs and installed.
- Re-program control system and incorporate fan cycling.
- Complete field evaluation to ensure fan cycling strategy performs properly.

EEO-9 DEFROST TERMINATION

Controls and devices can be incorporated to minimize *duration* of defrosts. Length of evaporator defrost is usually set up once and based on requirements for worst case scenario (high humidity of mid-summer). During other times of the year when the frost build up is lighter, duration of defrost is excessive and imparts a “false load” on the central plant. It is possible to incorporate defrost controls that minimize length of defrost to *only that amount of time required* to melt all ice. This is usually done by incorporating a temperature sensor in the defrost relief line to sense when condensed liquid turns to pure hot gas. Potential energy savings associated with this strategy for four () defrost control groups for coolers is as follows:

Reduced annual energy use	**27,757 kwh/yr**
Reduced peak power	**0 kw**

Reduced operated costs	**$2,470/yr ($.089/kwh avg)**
Approximate Cost:	**$4,000**
Simple payback:	**1.7 years**

Above savings assumes that each 6 deg-f defrost control group has a defrost relief regulator that is a ¾" port A4AK valve.

Recommendation
To implement this EEO, the following tasks are required:

- Complete engineering to determine devices, wiring and controls required to implement
- Secure costing from qualified electrical contractor to complete control wiring and controls specialist to incorporate into central PLC for defrost sequencing..
- Evaluate payback associated with reduced operating costs and installed.
- Execute installation
- Re-program control system accordingly.
- Complete field evaluation to ensure defrost termination strategy performs properly.

EEO-10 VARIABLE-SPEED SCREW COMPRESSORS
Compressor capacity and models are selected to meet the peak refrigeration demand. Analysis shows that average load is much less than peak load. Under "average" conditions, one or more compressors could be running partly loaded. Screw compressors have a poor part load performance curve. The solution to this is to run the compressors at 100% of slide valve and vary speed of motor and compressor to match load. This scenario maximizes compression efficiency. Our analysis of the annual load profiles, relative to compressor capacity, reveals that one compressor retrofitted with Variable Speed Drive will be beneficial in terms of: energy efficiency, accommodate the refrigeration load more smoothly and minimize starting/stopping of compressors with 500 hp+ motors. Installing one or more variable speed compressors may be justifiable. Compressor loading (slide valve position) will need to be evaluated nearly on a minute-by-minute basis. This information could be extracted from historical trending via the central control system. Evaluation will be to determine:

- If short cycling of compressors is occurring on a regular basis
- Duration of time compressor(s) operate part load
- How low these partly loaded compressors are operating

Recommendation
To quantify potential energy savings of a variable-speed drive compressor (s), compressor loading (slide valve position) will need to be evaluated nearly on a minute-by-minute basis. This information could be extracted from historical trending via the central control system. Evaluation will be to determine:

- Duration of time compressor(s) operate part load

- How low these partly loaded compressors are operating

If it is determined there are numerous opportunities to accommodate fluctuations in plant load and reduce performance penalty of part-load operation the following steps should be taken:

- Secure factory pricing to convert SC-1, SC-2 or SC-3 to variable frequency drive (motor, VFD, controls modifications, engineering, etc.)
- Secure costing from qualified electrical contractor to complete all necessary power wiring and control wiring.
- Evaluate payback associated with reduced operating costs and installed.
- Final engineer the electrical modifications necessary to make changes to VSD.
- Procure VFD and Inverter duty motor from Vilter.
- Execute installation of VFD, new motor and controls modifications associated with on-board micro and central control panel.
- Re-program compressor sequencing accordingly.
- Complete field evaluation of new VFD compressor and sequencing to ensure plant's refrigeration needs are satisfied and compressors are performing properly.

ADDITIONAL SYSTEM OBSERVATIONS AND RECOMMENDATIONS

CONDENSERS

Industry standard practice in Wisconsin is to size condensers for peak load and with a 78 deg-f wet bulb and 95 deg-f condensing temperature (17 deg-f approach). Under the

design conditions listed above, it was found there is about 13% excess installed condenser capacity over installed compressor capacity. There is 34% excess installed condenser capacity over heat rejection of 5 of 6 compressors expected to operate at maximum capacity. That is, one of the VSS-2101 compressors is off line. See the heat rejection assessment of compressor vs condenser in the attached supporting documents.

At this time, it is suggested additional condenser NOT be installed.

INTAKE MILK SILOS

There is very little pulldown load associated with in-coming milk. The vertical silos are essentially holding temperature only. There is essentially only one method to reduce refrigeration load associated with these silos. Prior to initiating CIP, each individual tank should be allowed to "pump down" any remaining liquid ammonia such that its surge drum and jacket contain vapor only and do not impart a false load by boiling out remaining liquid refrigerant.

LOAD SHIFTING

Load shifting is a strategy to reduce operating costs by shifting refrigeration loads to off-peak hours and take advantage of lower utility rates during those off-peak hours. As this facility is a 24 hour operation 7 days per week, there is little opportunity to shift loads and should not be considered for an energy savings strategy.

BRINE CHILLING

Brine chilling in itself is a production requirement and not subject to any efficiency initiatives. The "load-is-the-load" and cannot be modified.

WHEY CHILLING

Whey chilling via the sweet water system is a production requirement and not subject to any efficiency initiatives. The "load-is-the-load" and cannot be modified. Whey does have a re-generation section

HEAD PRESSURE CONTROL

In lieu of establishing a minimum condensing pressure set point (irrespective of ambient west bulb temperature) and forcing condenser fans and pumps to operate and "drive" the condensing pressure down as low as possible, a preferred control strategy is to minimize the combination of compressor and condenser fan energy. Currently, head pressure control is set for 125 psig (75 deg-f). This control point will be impossible to achieve when ambient wet bulb temperature is say 65 deg-f or higher. During these conditions, fans and pumps will all be operating at full speed in an unsuccessful attempt to drive condensing pressure down to 75 deg-f. Control logic can be incorporated to reset target condensing temperature to track ambient wet bulb temperature. That is, maintain an appropriate "spread" throughout the year to minimize the combined

horsepower of compressor power and fan energy. It has been found that a 12-14 deg-f differential between condensing pressure and ambient web bulb is the “sweet” spot. Reduced operating cost associated with this strategy is very difficult to quantify as there are multiple variables changing throughout the course of a year (refrigeration load, wet bulb temperature, dry bulb temperature, condenser water, etc.). What is at stake are the hp in combined condenser fans. Intelligent head pressure control should be implemented into condensing pressure control strategy.

AUTOMATIC LIGHT CONTROL

It is fairly common practice to witness lights on 24 hours per day at cold or cooler storage facilities (either intentionally or accidentally). Installing automatic controls to minimize light on time will *not only* reduce energy use associated with the light fixtures themselves, but also the central refrigeration system. For the proposed facility’s operating conditions every 1 kwh of light energy consumed in coolers, takes .23 kwh of compressor energy to remove it. Consult with your design/build electrical contractor regarding the installation of motion sensors to reduce lighting “on” time. Energy savings can be quantified (lighting and refrigeration) and weighed against the cost for the motion sensors and associated control wiring.

LED LIGHTS

Substantial energy savings could be achieved by converting from existing fluorescent to LED lighting. It is fairly common practice to witness lights on 24 hours per day at production plants such as Foremost Farms (either intentionally or accidentally) even when there is little or no traffic. Installing LED will *not only* reduce energy use associated with the light fixtures themselves, but also the central refrigeration system. For this facility’s operating conditions every 1 kwh of light energy consumed in coolers, takes .23 kwh of compressor energy to remove it. Consult with your design/build electrical contractor regarding the economics of energy savings associated with installation of LED lighting plant wide. Energy savings can be quantified (lighting and refrigeration) and weighed against the cost of LED fixtures and associated control wiring.

PREMIUM EFFICIENCY MOTORS

Premium efficiency motors are more costly than standard or even high efficiency motors. The impact is obvious: less energy use at the motor and less heat generated to refrigerated spaces. Energy savings would be achieved with premium efficiency motors for:

- Evaporator fans
- Compressors
- Condenser fans
- Condenser pumps

Energy savings associated with premium efficiency motors is quantifiable, however, the grant for premium efficiency motors is usually a “prescriptive measure”. Submit the paperwork for these motors to qualify.

HOT WATER HEATING

It is also possible to absorb the low-grade heat from this ammonia system to substantially reduce energy consumption associated with hot water generation for cleanup and CIP. An industrial-grade ammonia heat pump could be installed to efficiently provide most of the plant’s hot water. A separate analysis would be required and is outside the scope of this Technical Audit. What would be required are a load profile (gpm) and temperatures (inlet & outlet) of hot water generated over the course of a year. A heat load profile could then be developed to establish need vs availability of the central ammonia refrigeration plant’s heat rejection to condensers. An added benefit of a heat pump system is that it can avoid the need for more evaporative condenser as the “evaporator” portion of the heat pump is a “condenser” for the ammonia system.

RECOMMENDATIONS:

Some recommendations above will require firm price quotations to determine their actual implementation cost. Requests for quotations (RFQ’s) from a qualified ammonia refrigeration contractor should be developed for specific Energy Efficiency Opportunities (EEO’s). If paybacks for above EEO’s are within acceptable criteria, it is recommended that Focus on Energy provide a grant and motivate Foremost Farms Foods to move forward with implementing some (or all) measures described previously.

5.3 Appendix C: Energy Savings and Incentive Calculations from Focus on Energy

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From 12-month pilot to permanent process

Foremost Farms
Plover, WI

Foremost Farms began its energy efficiency work with a 12-month pilot program to test the concept of Strategic Energy Management. Five years later, with specialized support from Focus on Energy, Foremost Farms has developed an Energy Management and Efficiency System that allows them to optimize operational efficiency for the most significant users in their plant, saving them more than $135,000 to date. In addition, they've become one of only five DOE 50001 Ready-recognized companies in Wisconsin, a recognition given for energy-efficient business operations.

Foremost FARMS · USA

Upgrades

- Strategic Energy Management (SEM)
- Energy Management and Information System (EMIS)

Results

$135,000
in cost savings to date

DOE 50001 Ready
recognized

5.4 Appendix D: Focus on Energy's Energy Efficiency Excellence Award to Foremost Farms, 2020

Foremost Farms Concentrates on Energy Savings, Doubles Up on Award

2020 Energy Efficiency Excellence Award Winner

10/05/2020

Appleton, Wis. – Foremost Farms USA, a milk processing company, received double the honor for its impressive commitments to energy efficiency. Along with its Plover facility, the company's Appleton location won a 2020 Energy Efficiency Excellence Award from FOCUS ON ENERGY® and Foremost Farms' utility provider, We Energies. The award was presented during a virtual award presentation to recognize the company's accomplishments.

Since 2018, Foremost Farms has completed four energy assessments in its Appleton facility and identified 25 opportunities for improve efficiency in its operations. To date, the processor has completed 11 of these upgrades, which include lighting improvements, steam and compressed air system leak repairs, installing more efficient blowers and electrical systems, adding no-loss condensate drains, and installing variable speed drives on process pumps.

"Your approach of analyzing facilities and processes and taking steps to implement efficiency projects is truly admirable," said Commissioner Tyler Huebner from the Public Service Commission of Wisconsin, who attended the presentation and offered his congratulations. "Focus on Energy is proud of your commitment to energy efficiency in Wisconsin."

Foremost Farms has also taken the extra step to prioritize energy efficiency as th
makes behavioral and cultural adjustments within the organization. The compar
continuously demonstrates their dedication to reducing energy waste and has made a point to

Energies representative Jim Stebnicki, who nominated Foremost Farms for the award. “Through a collaborative effort, they identified efficiency opportunities and took those recommendations seriously.”

The Appleton facility has a dedicated Energy Team that meets every month to discuss potential energy efficiency improvements. Facility staff, representatives from We Energies and the company’s Energy Advisor from Focus on Energy, Bill Lumsden, also attend the meetings.

“The Appleton team earned this award,” Lumsden said during the award presentation. “They’re persistent in their energy efficiency work and have been successful in saving energy in their plant. From the beginning, the Appleton team impressed me with their enthusiasm and commitment to energy efficiency.

By completing energy efficiency projects through Focus on Energy, Foremost Farms will see energy savings estimated at over 1,000,000 kilowatt-hours (kWh) and 20,000 therms annually. This is equivalent to burning 895,600 pounds of coal.

“[These projects] have been a huge win for us,” said Mueller. “Not only are we saving on energy, we’re save on chemicals we were using and wastewater. [The upgrades] make a safer and better place to work. It’s been a big benefit for us and we’ll continue with these programs.”

Each year, Focus on Energy selects customers who have shown a commitment to leading in energy efficiency to receive an Excellence Award. Foremost Farms’ demonstrated commitment to energy efficiency shows beneficial results for the processor’s financial savings, foundational growth, and statewide environmental impact – and will continue to do so for years to come.

Focus on Energy is working with utility companies across the state throughout September and October to present Energy Efficiency Excellence Awards to 14 outstanding businesses.

Focus on Energy, Wisconsin’s energy efficiency and renewable energy resources program, partners with 107 utilities across the state to offer energy expertise and financial incentives to residents and businesses that choose to reduce energy waste. A third-party evaluation last year revealed Wisconsin runs the most cost-effective energy efficiency programs in the nation, in terms of energy savings per dollar spent. A separate evaluation released this year found every $1 invested in Focus on Energy generates $4.80 in benefits for Wisconsin, including economic

Focus on Energy is Wisconsin utilities' statewide energy efficiency and renewable resource program funded by the state's investor-owned energy utilities and participating municipal and electric cooperative utilities. Focus on Energy works with eligible Wisconsin residents and businesses to install cost-effective energy efficiency and renewable energy projects. Focus on Energy information, resources and financial incentives help to implement projects that otherwise would not be completed. Its efforts help Wisconsin residents and businesses manage rising energy costs, promote in-state economic development, protect our environment and control Wisconsin's growing demand for electricity and natural gas. For more information call 800.762.7077 or visit www.focusonenergy.com

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Focus on Energy Announces Annual Award Winners on Earth Day

2020 Energy Efficiency Excellence Award winners

04/22/2020

Madison – FOCUS ON ENERGY® is recognizing businesses and other groups across Wisconsin today for the impact each has made on the state through energy efficiency. The revealing of the Program's annual Energy Efficiency Excellence Award winners coincides with Earth Day.

Focus on Energy, the statewide energy efficiency and renewable resources program, worked with its partner utilities across Wisconsin to choose 13 winners this year, each honored for efforts to reduce energy waste.

"It was very competitive this year. The submissions we received from our field staff and partner utilities were among the best we've seen," said Erinn Monroe-Nye, Focus on Energy Program Director. "This year's winners represent the groups across Wisconsin making smart energy decisions that will bring lasting change to Wisconsin. They are lowering their energy costs while making the state's economy more globally competitive."

This year's winners include:

- Advance Die Cast (Milwaukee)
- Ashley Nelson Homes (Milton)
- Aurora Health Care (Two Rivers)
- Bright Wood Corporation (Menomonie)

- Fuller's Milker Center, Inc. (Lancaster)
- Mercury Marine (Fond du Lac)
- Mosinee School District (Mosinee)
- Pierce Manufacturing (Appleton)
- Pukall Lumber Company (Arbor Vitae)
- WPS Health Solutions (Madison)

"Focus on Energy provides a tremendous value to our state. It saves participating customers money on their energy bills, it saves costs for everyone by reducing power needs, and of note on Earth Day, it is an environmental win for Wisconsin because it reduces emissions," said Tyler Huebner, Commissioner, Public Service Commission of Wisconsin.

Focus on Energy offers energy expertise and financial incentives to help Wisconsin homeowners, businesses and other groups invest in energy-efficient equipment and practices.

By getting in on energy efficiency, this year's award winners not only see reduced energy consumption and cost savings – they also support technology innovation, job creation, lowered environmental impacts, increased competitiveness and reduced dependence on nonrenewable resources. The most recent third-party evaluation of Focus on Energy found:

- Focus on Energy projects completed in 2018 contributed to first-year annual electricity savings of more than $90 million
- Participant satisfaction with the Program increased to 9.1 out of 10
- Participation increased in 13 of 16 core programs
- Every $1 invested in Focus on Energy programs creates more than $5 in benefits for Wisconsin, including economic benefits, reduced energy costs and reduced pollution.

Below is more about the qualifications of each winner:

Advance Die Cast

Advance Die Cast LLC, an aluminum die caster in Milwaukee since 1920, has been updating to more efficient equipment since The Mumford Companies purchased the foundry in 2015. Projects include upgrading melting furnaces and recovering exhaust heat to help in the melting process. Advance Die Cast also upgraded five holding furnaces and the company has upgraded to LED lighting in its production areas, offices and exterior. The combined projects are saving

Ashley Nelson Homes

Ashley Nelson was among the first real estate professionals to become a Focus on Energy Ambassador in 2019 and educating her customers on energy efficiency is now a cornerstone of her business. She has even started giving her clients closing gifts that focus on energy efficiency. For one client, she paid to have all their can lighting upgraded to LEDs. In less than one year, Ashley has referred more than 30 homebuying clients to Focus on Energy and put more than $4,000 in heating and cooling tune-up vouchers in the hands of her clients. Ashley also practices what she preaches, completing energy efficiency upgrades at both her home and office.

Aurora Medical Center in Manitowoc County

Nominated by its utility, Two Rivers Water & Light, the medical center was honored, in part, for a recently installed and implemented full building automation system that tracks and analyzes energy use throughout the facility. The staff has made it a priority to implement energy efficiency measures and practices to ensure that the hospital sustains a minimum carbon footprint, and their consistent efforts in energy efficiency have earned the facility an ENERGY STAR® Certification.

Bright Wood Corporation

Bright Wood Corporation, a maker of wood components and millwork, completed six energy efficiency projects at its Menomonie facility in 2019, including lighting upgrades, installation of a pressure/flow controller for its compressed air and replacement of air paint mixers with electric paint mixers. Projects completed in 2019 will provide the company annual savings of 100,109 kilowatt hours of electricity, which has the carbon dioxide equivalent of 77,000 pounds of coal burned.

Cascades Tissue Group – Eau Claire

Cascades Tissue Group's integration of strategic energy management into its culture makes it a worthy winner. Cascades shows its commitment to energy efficiency through capital funding projects, energy measurement and site engagement. The company has taken advantage of Focus on Energy's financial incentives and integrated efficiency into its business strategy. Following an energy audit in 2016, Cascades has incorporated best practices, implemented

Coextruded Plastic Technologies, Inc.

Coextruded Plastic Technologies (CPT) makes Go-Green trays, which have a reduced carbon footprint compared to conventional thermoforming. Directed to Focus on Energy by its utility, Alliant Energy, CPT has implemented multiple energy-saving projects like nine rooftop units installed in 2019 that include Advanced Rooftop Controls. These new units will help CPT save 14,575 therms of natural gas and 301,049 kilowatt hours of electricity annually. That's enough to power more than 250 homes for a full year.

Foremost Farms USA

Foremost Farms USA has made such a commitment to energy efficiency that two of its facilities – Plover and Appleton – were nominated for the award this year. Since the Plover facility started participating in Focus on Energy's Strategic Energy Management program, it has seen more than $135,000 in energy savings. The Plover facility has also been recognized as 50001 Ready by the U.S. Department of Energy for establishing businesses practices around energy. The Appleton facility has also demonstrated outstanding commitment to energy efficiency through capital projects and behavioral changes. The facility has an energy team that meets monthly with their Energy Advisor from Focus on Energy and representatives from their utility, We Energies. The Appleton facility has implemented 11 efficiency projects over the past two years, including

lighting improvements and leak identification and repair of both steam and compressed air systems. The projects have netted annual energy savings of more than $78,000.

Fuller's Milker Center

Fuller's Milker Center, a Focus on Energy Trade Ally contractor, has helped more than 165 customers achieve energy savings and receive financial incentives through Focus on Energy over the past eight years. Fuller's has promoted Focus on Energy's agribusiness multiple equipment bonus to help its customers install more pieces of efficient technology and achieve more savings.

Mercury Marine

Mercury Marine is driven by environmentally conscious production and sustainable energy

electricity and 169,000 therms of natural gas annually, enough to power 478 homes for a year. The company is also saving more than a quarter of a million dollars annually from energy reduction. When expanding facilities at its headquarters in Fond du Lac, the company has used energy-efficient climate control and water-heating equipment, and it has used windows and natural light elements in the designs as a way to lower energy costs.

Mosinee School District

The school district and Director of Buildings and Grounds Steve Kaiser have been very proactive about efficiency and energy savings in district facilities. The district has three school locations totaling more than 438,000 square feet. Energy efficiency projects have included boilers, LED lighting, lighting controls and equipment that controls energy use in the motors of various equipment.

Pierce Manufacturing

Pierce Manufacturing's energy efficiency projects have included extensive production changes, building envelope upgrades, indoor and outdoor lighting upgrades, compressed air improvements and improved motor controls. Projects from 2018 to present are saving the company a half-million dollars annually and saving enough energy each year to power more than 600 homes.

Pukall Lumber

Pukall Lumber recently completed a project that consolidated several dust collectors, enabling them to remove 108 horsepower of motors, with annual energy cost savings of $22,600. This family-owned sawmill in Arbor Vitae has been working with Focus on Energy since 2002 and has completed more than 15 energy efficiency projects at the mill during that time. The company has also made LED lighting upgrades at its showroom stores in Arbor Vitae, Manitowish Waters, Woodruff and Minocqua.

WPS Health Solutions

WPS Health Solutions in Madison has made saving energy a priority, completing more than 25 major energy efficiency projects since 2017. This includes more than ten major LED lighting

projects are saving WPS hundreds of thousands of dollars in avoided energy costs.

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