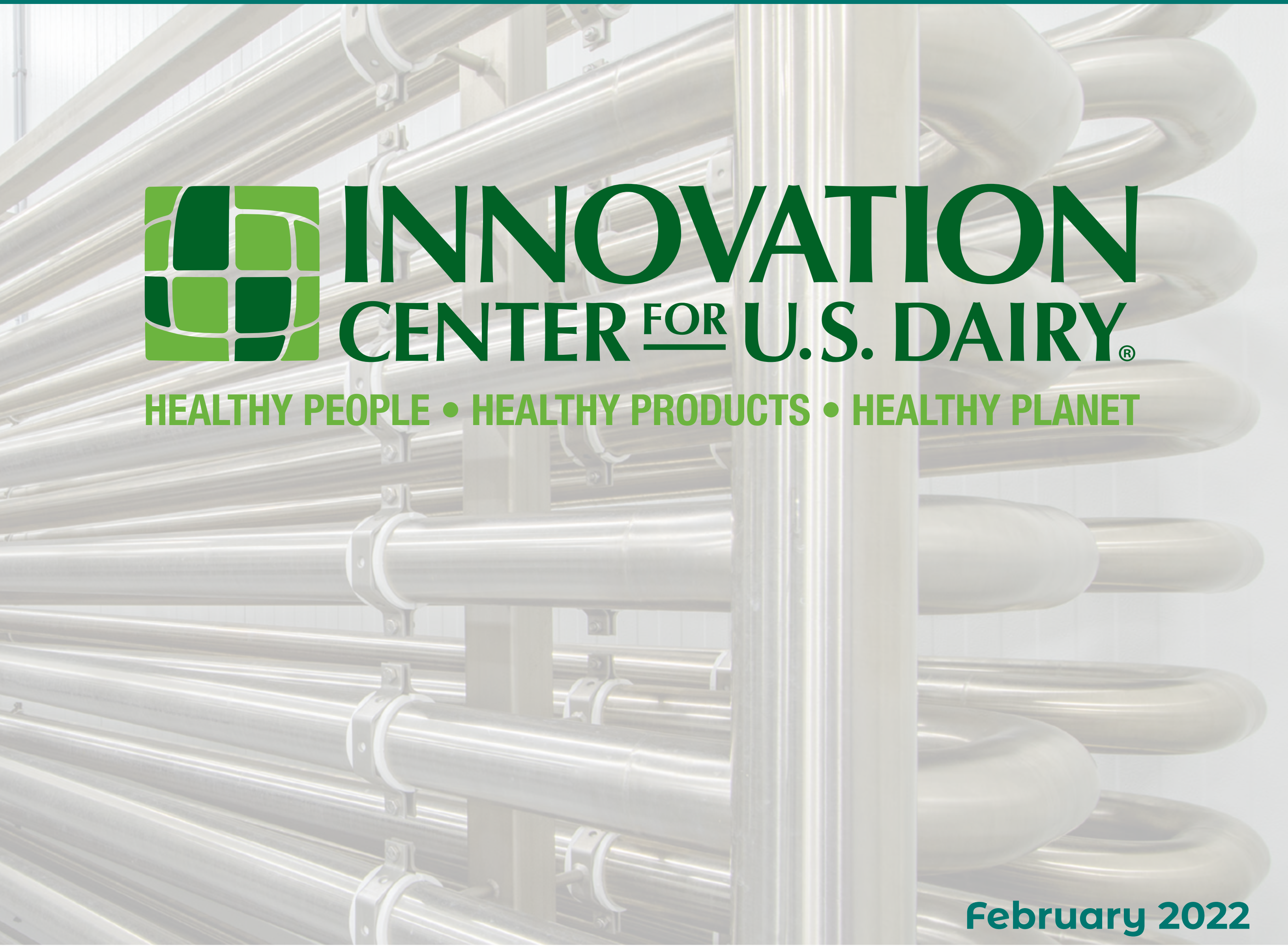
DAIRY PROCESSOR
GHG REDUCTION OPPORTUNITIES GUIDANCE

IN COLLABORATION WITH THE DAIRY PROCESSOR WORKING GROUP GHG SUBCOMMITTEE



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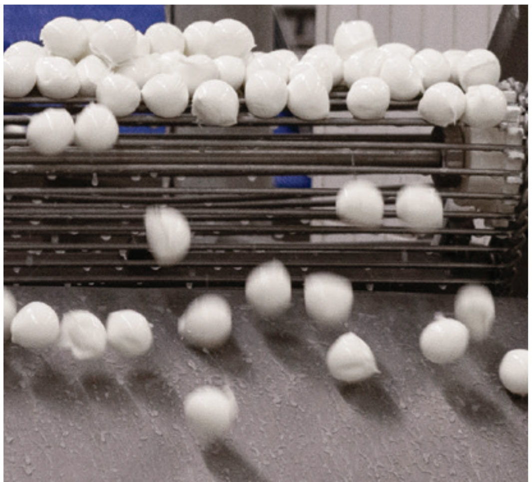


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Introduction

In 2020, the Innovation Center for U.S. Dairy set an industry-wide goal to achieve GHG neutrality by 2050. In this context, "industry-wide" includes the field, dairy farm, and processor levels of the supply chain. To make progress towards, and ultimately achieve this goal, U.S. dairy will need to rely upon individual companies to contribute to the aggregate.

To pre-competitively provide guidance for U.S. dairy companies and equip them to drive progress against the industry's GHG neutrality goal, the Processor Working Group GHG Subcommittee developed this document, which details strategies, practices, technologies and supporting resources for dairy processors to lower their GHG emissions footprint.

The guidance is structured into two main sections:

- GHG Reduction Opportunities within Operational Control (Scope 1 and 2)
- GHG Reduction Opportunities within the Supply Chain (Scope 3)

This organization is intended to encourage processors to focus on GHG reduction tactics within their own control first, and then shift their focus to opportunities to further mitigate emissions, such as partnering with suppliers and offsetting. This approach is the standard best practice as defined by reputable GHG target setting frameworks such as the Science Based Targets Initiative.

Lastly, this guidance is intended to be a living document, with relevant updates and changes made on an ongoing basis to ensure it provides optimal value. Therefore, feedback is always welcome on ways to enhance this document and should be sent to Eric Hassel (Eric.Hassel@dairy.org) at the Innovation Center for U.S. Dairy.

Tools and Resources

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Tool/Resource	Description
Carbon Offset Guide	Guide for companies and organizations seeking to understand carbon offsets and how to use them in voluntary GHG reduction strategies. Explains what role purchases of other environmental commodities, like renewable energy credits (RECs) and emission allowances, can serve in claiming GHG emission reductions. Provides an educational resource for technical experts in academia and government.
Clean Energy – Department of Energy	Government website providing information on various forms of clean and renewable energy.
Clean Energy Buyers Alliance (CEBA)	Membership association for energy customers seeking to procure clean energy across the U.S. Current membership of almost 300 includes stakeholders from across the commercial and industrial sectors, nonprofit organizations, and energy and service providers.
Database of State Incentives for Renewables & Efficiency (DSIRE)	Contains comprehensive information on incentives and policies that support renewables and energy efficiency in the United States. Operated by the N.C. Clean Energy Technology Center at N.C. State University.
Electric vs. Gas-Fueled Forklifts	A comparison of electric and gas-fueled forklifts including the functional advantages and disadvantages of each, and long-term costs.
Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry	Discusses energy efficiency practices and energy-efficient technologies that can be implemented at the component, process, facility and organizational levels. Developed by the Ernest Orlando Lawrence Berkeley National Laboratory.
ENERGY STAR Focus on Energy Efficiency in Dairy Processing	A partnership between EPA's ENERGY STAR program and dairy processing companies to improve energy efficiency within their operations. Provides tools to help improve manufacturing energy efficiency, save money and reduce greenhouse gas emissions.

Tools and Resources

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)	
Tool/Resource	Description
EPA Clean Energy Programs	EPA program designed to help energy consumers in all sectors, state policy makers, and energy providers by providing objective information, creating networks between the public and private sector and providing technical assistance.
EPA SmartWay	EPA program that helps companies advance supply chain sustainability by measuring, benchmarking, and improving freight transportation efficiency.
Five Transportation Management Optimization Practices	Provides five strategies to optimize freight transportation to improve sustainability and reduce costs. Developed by GlobalTranz.
Freight Wing and Aerodynamic Fairings	Information from the Office of Energy Efficiency & Renewable Energy on the benefits of freight wings and aerodynamic fairings, including energy, GHG emissions, and other pollutant savings.
Green-e	Program that provides businesses and individuals with certified, verified clean energy. Advocates for advancement of clean energy policy, markets, and technology.
International Council on Clean Transportation (ICCT)	Independent nonprofit organization founded to provide first-rate, unbiased research and technical and scientific analysis to environmental regulators. Its mission is to improve the environmental performance and energy efficiency of road, marine and air transportation in order to benefit public health and mitigate climate change.
Low-GWP Refrigerants and How it is Affecting the HVAC Industry	Information on the history of HVAC refrigerants, the EPA Clean Air Act and SNAP, and lower emitting alternatives in HVAC systems.
North American Council for Freight Efficiency (NACFE)	Works to drive the development and adoption of efficiency enhancing, environmentally beneficial, and cost-effective technologies, services and methodologies in the North American freight industry.
North American Council for Freight Efficiency - Trailer Fairings	NACFE information on the benefits, challenges, strategies and decision-making tools associated with trailer fairings and aerodynamics.
RE100	The global corporate renewable energy initiative bringing together hundreds of large and ambitious businesses committed to 100 percent renewable electricity.
Transitioning to Low-GWP Alternatives in Commercial Refrigeration	Fact sheet providing information on low-GWP alternative refrigerants to high-GWP HFCs for use in commercial refrigeration equipment.

GHG Reduction Opportunities within the Supply Chain (Scope 3)	
Tool/Resource	Description
Closed Loop Partners	Investment firm comprised of venture capital, growth equity, private equity and project finance focused on positive social and environmental impact by reducing waste and greenhouse gas emissions via materials innovation, advanced recycling technologies, supply chain optimization and landfill diversion.
Ellen MacArthur Foundation	Charity committed to creating a circular economy, which is designed to eliminate waste and pollution, circulate products and materials and regenerate nature.
Institute for Feed Education & Research	Advances understanding and trust in a sustainable animal feed and pet food supply chain through timely research and education.

Tools and Resources

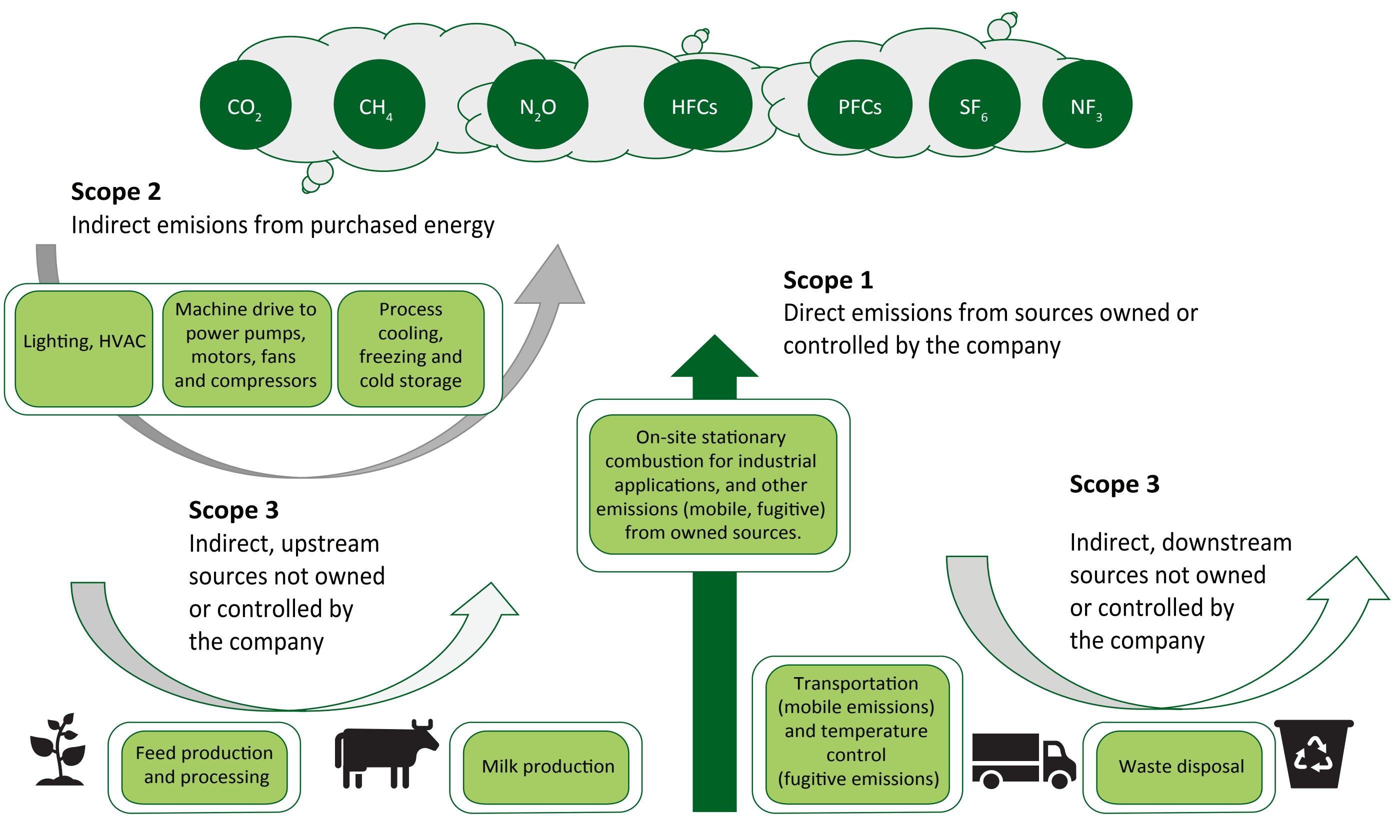
GHG Reduction Opportunities within the Supply Chain (Scope 3)	
Tool/Resource	Description
EPA Waste Reduction Model (WARM)	EPA tool to help solid waste planners and organizations track and voluntarily report GHG emissions reductions, energy savings and economic impacts from several different waste management practices.
Farm Powered Strategic Alliance	Collaborative movement to boost food waste reduction and recycling, and expand renewable energy production across America. Enables U.S. food manufacturers and retailers to recycle unavoidable food waste on farms where it is combined with manure in an anaerobic digester to generate renewable natural gas (RNG). Partnership between Vanguard Renewables, Unilever, Starbucks, Dairy Farmers of America, Cabot Creamery, and Stonyfield Organic.
How2Recycle	Standardized labeling system that clearly communicates recycling instructions to the public. Involves a coalition of forward-thinking brands who want their packaging to be recycled and are empowering consumers through smart packaging labels.
Institute of Scrap Recycling Industries (ISRI)	Promotes safe, economically sustainable and environmentally responsible recycling through networking, advocacy and education.
Newtrient Technology Catalog	Provides all dairy farmers with information regarding technologies that meet their farm's unique needs for manure and nutrient management and their own unique business goals.
Recycle Coach – How to Do a Waste Audit for Your Company	General information on how to conduct a waste audit for a company or organization.
The Recycling Partnership	Catalyzes improvements through leveraged seed grants, partnerships, and extensive reach to spark commitment, investment, and standards. Invests money into community programs and system solutions. Works with local governments, national brands, and industry leaders. Creates tools and opportunities for assistance and guidance with operations and outreach.
RoadRunner Waste Management	Provides technology through an urban logistics engine to recycle more as safely, efficiently, and environmentally friendly as possible. Offers a suite of recycling services.
SBTi Corporate Manual	Step-by-step guide for companies to set science-based targets, and ensure they are in compliance with the requirements of measuring and reporting against an SBT over time.
SBTi Criteria	Criteria which must be met in order for GHG reduction targets to be recognized by the SBTi.
SBTi Forest, Land and Agriculture (FLAG)	Sector-specific guidance and methodology to account and set science-based targets that include land-related emissions and removals.
SBTi How-To Guide	A guide to assist companies in where to start when setting science-based targets.
SBTi Net-Zero Standard	Provides guidance, criteria, and recommendations to support corporations in setting net-zero GHG reduction targets through the SBTi.
SBTi Target Setting Tool	Excel-based tool to enable companies to develop appropriate science-based emission reduction targets, and to assist companies and interested third parties in assessing and evaluating companies' targets.
Sustainable Packaging Coalition	Membership-based collaborative that believes in the power of industry to make packaging more sustainable. Their mission is to bring packaging sustainability stakeholders together to catalyze actionable improvements to packaging systems and lend an authoritative voice on issues related to packaging sustainability.
The U.S. Dairy Net Zero Initiative	Information brief on the U.S. Dairy Net Zero Initiative.

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Although many practices and technologies largely apply to all dairy processors, it is important to note that no two dairy processing facilities are the same. Every location has unique aspects driven by geography, products produced, process technologies, and more. Based on this, processors should consider conducting location-specific energy and utility audits, which may provide a good sense of where to start on GHG improvements.

Additionally, the improvements identified through these audits may have attributable rebates, incentives, and cost coverage to assist companies in implementing more sustainable practices and technologies. Policies and incentives by state can be found in the Database of State Incentives for Renewables & Efficiency (DSIRE) in the Tools & Resources section.

Once opportunities throughout a facility are identified, processors can consult the specific guidance throughout this section to implement GHG improvements.



Common Scope 1, 2 and 3 emission sources in the dairy processing industry

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Building Energy Efficiency		
	Tactic	**Description**
Heating, Ventilation and Air Conditioning (HVAC)	Automatic Temperature Control	Utilize automatic temperature regulating equipment, such as programmable thermostats, to maintain minimum/maximum required temperature (depending on season) while maintaining employee comfort. These thresholds may be extended slightly during non-occupied periods.
	De-Stratification Fans	Consider using de-stratification fans to improve heating efficiency. Air that is closer to the ceiling is usually warmer than near the ground. De-stratification fans can help regulate air temperature throughout, which mitigates excess heat loss through building roofs due to inside/outside temperature differential.
	Efficiency Upgrades	Consider upgrading to higher efficiency HVAC systems. Examples include: • Replacing constant volume systems with variable air volume (VAV) units • Replacing older units with new/high-efficiency models
	Infrared Heating	Consider implementing an infrared heating system when large amounts of air are lost to the outside and/or when the employee working area is relatively small compared to the entire space.
	Routine Inspections	Conduct periodic inspections of heating and cooling ducts and repair any leaks that are found.
	Ventilation/Exhaust	Limit ventilation/exhausting of air from a controlled space to minimum but acceptable levels.
	Waste Process Heat	Identify opportunities to implement waste process heat for space heating.
	Water Vapor Release	Limit release of water vapor into air-conditioned spaces. Excess humidity typically must be removed by the air conditioning system, increasing energy consumption unnecessarily.
Lighting	**Tactic**	**Description**
	Over-Lighting	Identify the minimum light levels necessary for spaces throughout the facility to avoid over-lighting, which results in more energy use than necessary. For example, implement sensors to dim and/or shut off electric lighting during daylight hours in areas exposed to natural light (i.e., offices with windows). Removing and/or shutting down certain light fixtures in over-lit areas can limit energy consumption, thus reducing GHG emissions from purchased electricity (Scope 2).
	Retrofit/Replace Lighting with Light Emitting Diode (LED) Technology	Consider LED lighting system retrofits to replace inefficient technologies. In addition to being more energy-efficient, LEDs can help reduce air conditioning/cooling loads due to significantly lower heat output. This helps lower GHG emissions from purchased energy even more. LEDs can also include anti-microbial technology to purify surrounding air.
	Time-of-Day or "Dusk-to-Dawn" Sensors	Ensures that night lighting systems are not on during daylight hours, which helps save additional energy.
	Unoccupied Spaces	Implement practices and controls (e.g., occupancy sensors) to shut off or dim lighting fixtures in spaces that are subject to intermittent use and/or not used for extensive periods. Typical spaces that match this description are: • Storage areas • Offices • Restrooms • Locker rooms • Break rooms

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

	Tactic	Description
Boiler, Steam, and Condensate Systems	Automatic Oxygen Trim	If boiler steam load varies and/or flue gas oxygen levels are difficult to control, consider an automated oxygen trim system to maintain a proper air-to-fuel ratio and optimize fuel efficiency. • As a general rule, boiler efficiency increases 2.5 percent for every 1 percent reduction in flue gas oxygen.
	Boiler Blowdown Rates	Control boiler blowdown to "minimum, but adequate" levels. Blowdown rates should typically be based on conductivity or total dissolved solids (TDS) of the water. Improving the quality of the boiler feedwater can facilitate blowdown reductions. Additionally, surface/continuous blowdown systems can be implemented using conductivity sensors and control valves.
	Boiler Feedwater Quality	Monitor and manage boiler feedwater quality. This helps mitigate the risk for scaling within the boiler and subsequent fouling of internal heat exchange surfaces.
	Boiler Load Optimization	When multiple boilers are needed, implement controls to optimize the load from the most efficient boiler(s).
	Boiler Upgrades	Consider upgrading boilers with modern, energy-efficient burners. Modern boilers utilize servo motors with parallel fuel and air positioning to promote higher combustion efficiencies over a wider firing range. Efficient burners require only 2-3 percent excess oxygen over the entire firing range and can operate with a 10:1 or better turndown ratio. If excess oxygen is difficult to control on an existing boiler, or the boiler cycles off frequently due to poor turndown capability, upgrading the burner may be a cost-effective option.
	High-Efficiency Water Heaters	Consider using a high-efficiency direct contact water heater to displace steam load. Direct contact water heaters can achieve efficiencies up to 99 percent, and can heat water up to ~200˚F.
	Optimal Steam Condensate Return	Maximize return of steam condensate to boiler feedwater. Unreturned condensate results in not only the need for additional makeup water and processing chemicals (i.e., salt and boiler chemicals), but also thermal energy that is lost as heat, leading to increased energy consumption from space cooling.
	Reducing Cycling Frequency	Consider solutions to reduce cycling frequency if boiler/burner cycling is frequent, such as turn-down improvements and load leveling. Every time a boiler cycles off, there is a pre- and post-purge of air that leads to lost energy.
	Routine Boiler and Burner Maintenance	Conduct routine tuning of plant boiler and burner systems to maintain high combustion efficiency. Higher combustion efficiency results in less energy consumption, ultimately lowering GHG emissions from natural gas combustion and other fuels (Scope 1). • The primary indicators of combustion efficiency are stack gas temperature and oxygen concentration. As a general rule, boiler efficiency can be increased by 1 percent for every 40˚F reduction in stack gas temperature, or 15 percent reduction in excess oxygen.
	Steam Header/Boiler Pressure	Minimize steam header/boiler pressure set points.

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

	Tactic	Description
Boiler, Steam, and Condensate Systems	Steam Venting Control	Control steam venting from the feedwater deaerator system to be "minimal but adequate."
	Steam/Condensate Trap Maintenance	Ensure the correct traps are used, test them routinely, and ensure they are maintained. Checking traps to ensure they are functioning correctly is an easy way to save significant amounts of energy for almost no cost.
	Variable Speed Controls	If combustion airflow is controlled by a damper, consider options to control fans by variable speed drive (e.g., VFD-control).
	Waste Heat Recovery	Consider waste heat recovery opportunities, such as: • Boiler blowdown, which can potentially be used to pre-heat makeup water or combustion air. • Feedwater economizers, which can be installed for stack heat recovery. • ***Note:*** *Economizer temperature is dependent on feedwater temperature. Acid dew point concerns should be considered when planning (for non-condensing economizers).* • Flash steam from blowdown and/or condensate receivers, which can be used to pre-heat makeup water or combustion air.
	Water System Insulation	Implement and maintain insulation on hot water system components, boilers, steam piping, condensate return components and other steam systems (i.e., heat exchangers) where possible. Insulation reduces thermal energy lost as heat, thus reducing the need for additional energy consumption for space cooling. • As a general rule, fuel efficiency increases 1 percent for every 40˚F reduction in saturated steam temperature.
Compressed Air Systems	**Tactic**	**Description**
	Air Drying Efficiency	A cycling-type refrigerated dryer is generally considered most efficient when dew point requirements are not extremely low.
	Air Intake Relocation	If the existing compressor air intake is impacted with hot or contaminated air, consider relocating the air intake. Cooler, denser air improves compressor mass flow and pressure capabilities, particularly in centrifugal compressors.
	Automatic Shutoff	If one or more compressors are running at zero capacity for extended time periods, consider installing automatic shutoff timers.

	Compresses Air Efficiency	Eliminate unnecessary or inefficient uses of compressed air. Conduct a facility air system walkthrough to assess all equipment/systems using compressed air. Where possible, itemize pressure and flow requirements for each system. Examples of unnecessary/inefficient use include:
		• Equipment that uses air while it is idle or not being used
		  • Implementing solenoid-controlled valves to shut air off when idle is a solution
		• Open-ended cleaning wands
		  • Using high-efficiency nozzles or using a different cleaning method is a solution

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

Compressed Air Systems

Tactic	Description
Condensate Removal	Minimize air loss that occurs with condensate removal devices. Inspect condensate drain traps periodically, and repair/replace when needed. When more expensive repairs are necessary, consider installing zero-loss traps, which waste no air and can be effective alternatives to manual, timer-based and other traps.
Discharge Pressure	Operate compressors at the minimum required discharge pressure. Evaluate plant equipment/systems using air to assess actual air pressure and flow requirements and any related constraints on lowering pressure at compressors. Further, evaluate the air distribution system to assess any problematic conditions that may hinder lowering air pressure (e.g., distribution pipe is too small, hence causing friction-related pressure losses). • As a general rule, compressor energy usage is reduced by 1 percent for every 2 pounds per square inch (psi) pressure reduction.
Downsizing	If large, partially loaded compressors are serving minimal needs during off-hours, consider installing smaller compressors that more efficiently meet these needs.
Efficient Alternatives	Consider more efficient alternatives if inlet-throttling modulation is used to control compressor output capacity, or if variable displacement techniques are used. Examples of potential options include: • Replacing existing capacity control method with "load-unload" control technique • Increasing storage/received capacity and replacing existing capacity control method with "load-unload" • Installing variable speed drive capability for the trimming compressor
High-Efficiency Alternatives	Consider higher efficiency cost-effective alternatives for high-pressure compressed air applications. Examples include: • Replace venturi-type vacuum generators with dedicated vacuum pumps • Use low- or medium-pressure blowers/fans where applicable • Use high-efficiency nozzles rather than "open blowing" • Replace compressed air-based cabinet coolers with dedicated electric cooler units • Use low- or medium-pressure blowers for padding tanks or processes • Replace pneumatic motors with high-efficiency electric motors • Replace pneumatic conveying with mechanical conveying • Replace air sparge mixing with mechanical mixers • Replace air-driven tools with electric tools • Consider electric actuators in lieu of air-operated actuators
Leak Monitoring/ Detection and Repair	Minimize air leaks through active monitoring and repair programs. This can be applied across all utilities and should be available for any employee to report a leak. Leaks can become a significant source of wasted energy in compressors, wasting as much as 20 – 30 percent of compressor output. Ultrasonic acoustic detectors are an effective method to identify leaks, as they recognize high-frequency hissing sounds.
Variable Speed Drives	When purchasing new compressors, consider variable speed drive options as a strategy to improve overall supply system efficiency. Two-stage compressors are also more efficient than single speed.

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

Compressed Air Systems

Tactic	Description
Multiple Compressor System Optimization	Optimize control strategies for systems with multiple compressors. When more than one compressor is operating, all except one should operate at full capacity, allowing compressors to meet varying demands while avoiding "conflicting" with each other, and operating at partial load is less efficient. Optimizing this control can be challenging, and affected by several factors, such as: • Storage capacity • Pressure/flow controllers • Fixed vs. variable speed compressor characteristics • Demand variability However, minimizing air usage before attempting to optimize controls is generally a good strategy.
Pressure Losses	If the air distribution system is experiencing high friction-related pressure losses, consider these options: • Installing "looped" piping to allow for alternative air routes • Installing larger diameter distribution pipes in high-pressure flow areas • Replacing undersized filters with larger ones
Preventive Maintenance	Conduct routine preventive maintenance to maintain efficiency. Inadequate maintenance increases energy consumption through lower compression efficiency, air leakage, and/or pressure variability. Common maintenance practices to consider include: • Monitoring and replacing inlet and discharged air filters • Replacing lubrication and cooling fluids • Monitoring alignment and adjusting belts • Identifying and repairing leaks • Monitoring pressure/flow control devices • Checking condensate removal devices • As a general rule, each inlet air temperature reduction of 5°F saves 1 percent of compressor energy.
Storage Capacity	Consider increasing storage capacity as an alternative to operating additional compressors. Storage capacity can often be used to manage peak demand and should be sized so additional compressors do not need to be turned on. Air entering a storage receiver must be at a higher pressure than the downstream system pressure; to achieve this differential, Pressure/Flow Controllers (P/FC) and/or metering valves can be implemented. In situations where only one or a few applications have intermittent air demand, a correctly sized storage receiver that is close to the point of the intermittent demand with a check valve and a "slow fill" metering valve may be an effective and lower-cost alternative. If done correctly, this will have the effect of reducing the large intermittent requirement into a much smaller average demand. • ***Note:*** *A compressed air specialist can be consulted to find a storage capacity strategy that meets system needs because design capacity can vary greatly for each situation and can be difficult to determine.*
Waste Heat Recovery	Consider waste heat recovery opportunities. Up to 90 percent of electrical energy used in industrial air compressors is wasted as heat. Several applications that may be cost-effective include: • Pre-heating boiler makeup water or combustion air • Pre-heating CIP/COP water • Seasonal heating of HVAC system makeup air

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

	Tactic	Description

Hydraulic Systems	High-Efficiency Pumps	Consider upgrading to higher efficiency pumps. Piston pumps are usually more efficient than gear pumps and vane pumps.
		• As a general rule, pump efficiencies are as follows:
		  • Gear – 75-80 percent
		  • Vane – 80 percent
		  • Piston – 95 percent

	Proportional Control Valves	Consider implementing proportional control valves to replace servo type valves. Proportional control valves result in lower pressure drop, which subsequently results in reduced hydraulic pump pressure loading and heat accumulation in the fluid.
	Unloading Valve System	Consider using an "unloading valve system" to reduce pump pressure after demand is satisfied, and hydraulic fluid is being returned to the sump.
	Variable Volume Pumps and Speed Drives	Consider replacing fixed displacement volume pumps with pressure-compensated variable volume pumps, or a variable speed drive on the pump. Fixed displacement pumps usually use a pressure reducing valve (PRV) to return fluid to the sump when system pressure is satisfied. Excess flow through the PRV results in energy loss. Pressure-compensated variable volume pumps reduce flow by varying displacement when a pre-set pressure is reached. Variable speed drives also can facilitate variable pump displacement.
Material Handling and Conveying Systems	Tactic	Description
	Automatic Shutoff	Control systems to automatically shut down when handling/conveying is not needed.
	Conveying Efficiency Improvements	Consider opportunities to improve pneumatic (vacuum or positive pressure) conveying system efficiency, such as: • Reducing blower/fan speeds to minimum, but adequate levels • Utilizing high-efficiency filtration • Replacing pneumatic transfer with mechanical conveying
Motors and Drives	Tactic	Description
	Belt Drive Configuration	Motors connected to the load via belt drives can be replaced with direct drive configurations, or replacing standard belts with high-torque/notched/cogged belts to increase efficiency. • As a general rule, high-torque belt drives reduce motor energy usage by 2-5 percent. Regardless of belt type, routine maintenance is key to check belt tension and other factors that influence performance and efficiency

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

Category	Tactic	Description
Motors and Drives	High-Efficiency Motors	Consider replacing low/standard efficiency motors with premium efficiency motors when they fail or require re-winding. Despite the high upfront cost, replacing standard efficiency motors with premium efficiency models is generally cost-effective if the motor operates at least 4,000 hours per year.
Motors and Drives	Motor Sizing	Size (or re-size) motors so they are typically loaded between 50 and 80 percent of full-load horsepower. Undersized/oversized motors do not operate at ideal efficiencies, particularly oversized motors routinely operating at <50 percent of full load. A good time to consider resizing is when motors need replacement.
Motors and Drives	Optimizing Operation	Implement operating procedures, interlocks, automation, or other controls to shut off motors during extended idle periods.
Motors and Drives	Routine Maintenance	Implement routine maintenance practices to ensure proper motor lubrication and cooling fan air flow.
Motors and Drives	Voltage Imbalance	Implement routine maintenance and monitoring processes to minimize imbalanced motor conditions. Voltage imbalance degrades performance and shortens motor life due to imbalanced current, which results in torque pulsing, increased vibration and mechanical stress, increased losses and over-heating. • Voltage imbalance may be caused due to an unbalanced transformer bank, open circuit, or by faulty operation of power factor correction equipment. • As a general rule, voltage imbalance at motor terminals should not exceed 1 percent. Voltage imbalances can be identified by monitoring voltage at the motor terminals and through regular thermo-graphic inspections.
Pasteurization Process	Heat Exchanger Improvements	Consider enhancing or replacing heat exchangers to improve efficiency. Plate and frame heat exchangers can be configured with turbulence enhancements or other flow profile characteristics. Also, ensure that the routine CIP process is removing the heat exchanger "fouling layer" that interferes with heat transfer.
Pasteurization Process	Heat Reclamation	Utilize or improve heat reclamation. Heat reclamation is commonly employed in the pasteurization process. Cooled milk coming out of the pasteurization process can be used to heat incoming cows milk to be pasteurized. An optimal heat reclamation process only requires a little thermal energy to finish heating incoming milk, and little cooling to finish processing outgoing pasteurized milk. Implementing a heat reclamation system when one did not previously exist can introduce significant energy and cost savings. Alternatively, existing reclamation systems can be made more efficient by adding plates to heat exchangers and/or improving heat exchange.
Pumps and Fans	Monitoring and Maintenance	Implement routine monitoring and maintenance practices, such as: • Wear monitoring and replacement of wear rings and worn impellers/blades • Vibration analysis and bearing inspection, lubrication, and repair • Packing and mechanical seal inspection and replacement • Pump/fan/motor alignment checks and adjustments • Belt drive checks and adjustments • Inspection and replacement of filters that can cause excess head losses

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

Pumps and Fans

Tactic	Description
Physical/Mechanical Restriction	Avoid operating pumps or fans that are physically throttled or mechanically restricted (e.g., throttling valve) to control flow. More efficient methods include those listed in the monitoring and maintenance tactic on page 11.
Piping/Duct Maintenance	Monitor and repair piping and/or duct leakage to minimize pump and fan system demand.
Piping/Duct System Design	Consider re-designing piping/duct systems to reduce frictional energy losses, such that the pump/fan system uses less energy or can be downsized. Common problems include: • Undersized piping/ducting • Undersized filtering systems • Substantial contracts or expansions in piping/ducting • Sharp and unnecessary turns in piping/ducting
Unnecessary Bypass or Recirculation Control	Avoid operating pumps or fans using unnecessary bypass or recirculation control methods. More efficient methods include: • Impeller trimming • Slower speed motor or re-sheaving • Variable speed drive control • On/off control method • Smaller pump/fan system

Refrigeration and Process Cooling Systems

Tactic	Description

Alternative Refrigerants	Replace hydrofluorocarbon (HFC)-based refrigerants in equipment such as refrigerators (cold storage and truck refrigeration), air conditioning units, building insulation, fire extinguishers, and aerosols. HFCs are greenhouse gases with extremely high global warming potentials (GWPs), meaning only a small quantity emitted results in a significant contribution to a GHG footprint. In light of the recent EPA rule issued under the AIM Act, and the potential Kigali Amendment ratification by the Senate, phasing out HFCs will no longer be optional. Therefore, processors can proactively phase out HFCs now to get ahead of upcoming regulations. Several alternatives with lower GWPs include:
	• Hydrocarbons (HC) – Consists of refrigerants like isobutane (R600a) and propane (R600a)
	  • *Note: These refrigerants are flammable, so measures must be taken to ensure safe operation*
	• CO_2 – R744 is a CO_2 based refrigerant with a low GWP, but operates at a peak pressure of 1,740 psi, which is much higher than the average of 290 psi in HFCs
	• Ammonia – Available as a refrigerant as R717.
	  • *Note: Ammonia is toxic and flammable, so measures must be taken to ensure safe operation*
	• R32 – A low toxicity, low GWP alternative, although supply is limited
	  • *Note: R32 is flammable, so measures must be taken to ensure safe operation*

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency		
	Tactic	Description

Refrigeration and Process Cooling Systems	Compressor Condensing/ Discharge Pressure	Operate ammonia/refrigerant compressors at "minimum but adequate" condensing/ discharge pressure targets. Minimum condensing pressure targets depend on a variety of factors. Effects of outdoor weather conditions and condenser capacity need to be considered within the context of other system requirements and characteristics. It is important to note that reducing condensing pressure normally increases condenser power use, but compressor energy savings typically exceed the increase in condenser energy consumption. Energy tradeoff becomes unfavorable only when available condenser capacity far exceeds operating compressor capacity. A wet-bulb approach control strategy helps balance capacities and minimize total power usage.
		• As a general rule, compressor energy usage is reduced by approximately 1.5 percent per 1˚F of reduction in condensing temperature.
		• Situations that may limit the feasibility of reducing pressure targets include:
		  • Hot gas defrost limitations
		  • Oil separator performance
		  • Thermal expansion valve performance
		  • Liquid injection oil cooling

	Compressor Suction Pressure	Operate ammonia/refrigerant compressors at the maximum allowable suction pressure target(s).
		• As a general rule, compressor efficiency increases approximately 2 percent per 1˚F increase in suction temperature.
		• Suction pressure can be negatively influenced by several factors. If possible, the following conditions should be met:
		  • Do not allow under-sized evaporator coils or heat exchangers that require substantially decreased compressor set points
		  • Do not allow a small, lower temperature load to dictate suction pressure for a larger, higher temperature load
		  • Avoid under-sized suction piping having excessive line losses
		  • Avoid unnecessarily low temperature targets for refrigerated spaces

	Condenser Sequencing	Sequence condensers to have the highest efficiency units operate first and most often. Condensers with axial fans are more efficient than those with centrifugal fans. Induced-draft designs are slightly more efficient than forced-draft designs. Further, condensers are very inefficient when operating while dry, so avoid control strategies that involve dry operation, except when necessary to protect against ice damage. Other factors to consider include: • Variable speed fan control • Coil scaling conditions • Spray nozzle design
	Control Strategy Optimization	Optimize control strategy for systems with compressors operating at less than a full load (part-load). Refrigeration compressors operating at part-load are less efficient vs. operating at full load. When multiple compressors are operational, all but one should operate at full capacity and efficiency. Use compressors with the most efficient part-load performance characteristics as the trimming unit. Reciprocating compressors with cylinder unloading have excellent part-load performance characteristics. Screw compressors have poor part-load efficiency, but can be improved with VFD-control. Various sequencing strategies should be implemented for systems with multiple compressors and variable load to align with operational compressors while simultaneously avoiding excessive motor starts/stops.

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

Refrigeration and Process Cooling Systems

Tactic	Description
Cooling Load	Minimize unnecessary cooling load on the refrigeration system. Common ways through which this can be done are: • Limiting infiltration of air through doorways • Using energy-efficient lighting technology within the refrigerated space • Ensuring that adequate insulation is used along the roof, walls, floors, piping, and vessels to reduce heat flow • Avoiding over-cooling of spaces
Defrost Cycle Times	Minimize defrost cycle times on evaporators in order to limit parasitic system loads that occur with undesirable heat added after the coil is defrosted.
Defrosting Efficiency	Consider defrosting efficiency improvements, such as: • Adjust defrost cycle times accordingly if conditions change seasonally. • Defrosting after a pre-determined dwell time of liquid feed to the evaporator. This typically provides a better match of only defrosting coils when needed. • Adjusting defrosting times to "off-peak" hours to save energy costs. • Implementing axial fans as opposed to centrifugal fans, as they use less energy.
Evaporator Fan Efficiency	Consider improving evaporator fan efficiency through the following strategies: • Consider installing additional temperature probes to ensure uniform temperatures are maintained at the desired target. • Consider a fan cycling strategy, such as cycling the fan off when the temperature target is achieved. When air flow is still desired, fans can run on an alternating cycle. • Consider using two-speed fans. Due to fan affinity laws, fan power usage at half speed is about 1/8th the power needed to run at full speed while moving about half the air. • Consider VFD-control. A single VFD can sometimes be used to control multiple fans within a single cooling zone.
Floating Head Pressure Control	Consider implementing a "floating head pressure" control strategy, which takes advantage of condenser capacity that may be available, particularly when wet-bulb outdoor temperatures are favorable. Competing effects of decreasing compressor energy and increasing condenser fan energy must be evaluated as an important element of the control strategy. Condenser control should involve automated control logic that adjusts target condensing pressure as a function of wet-bulb temperature.
Floating Suction Pressure Control	Consider implementing a compressor "floating suction pressure" control strategy in scenarios where the target suction pressure is dictated by processes that don't operate continually. Suction pressure targets "float," or change according to the operational schedule of key processes using this control strategy.
Free Cooling Opportunities	Consider taking advantage of "free cooling" opportunities. Facilities that are in cold and/or dry climates can use cold outdoor conditions to offset/supplement mechanical cooling. Further, a cooling tower, or fluid cooler/heat exchanger can be used to achieve free cooling.
Microclimates	Avoid heat/humidity "microclimates" around condenser equipment, which may be caused by poor placement, spacing, or proximity to other heat sources.

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Processing Infrastructure Efficiency

Refrigeration and Process Cooling Systems

Tactic	Description
Minimum Condensing Pressure	Evaluate and address barriers that may be preventing reduction in the minimum condensing pressure. Solutions may require consultation with equipment manufacturers. Examples of situations that may prevent reduction in minimum condensing pressure, and potential solutions are as follows:

Situation	Possible Solutions
Hot gas defrost system requires high pressure	• Reduce evaporator coil hot gas regulator and master hot gas regulator set points • Correct mechanical issues associated with hot gas piping or valves that are potentially causing excessive pressure loss • For multiple compressor systems, consider mechanical changes that allow one/two compressors to operate as dedicated suppliers of higher-pressure hot gas for defrosting • For systems not operating with continual defrosting, implement a strategy to increase compressor/hot gas pressure only when necessary • Implement mechanical and/or operational changes to eliminate/minimize the need for defrosting, such as evaporator coil pressure control modifications, or revised on/off cycling
Liquid injection oil cooling requirements prevent lowering of condensing pressure	• Retrofit or replace thermal expansion valves that require high-pressure differential for controllability with electronic expansion valves that require less pressure differential • Convert the system to external cooling • Install a pressure booster pump on the liquid injection line • Modify the injection ports
Oil separator performance suffers at reduced pressure due to lower gas density and increased gas velocity through separation devices	• Modify internal baffling of existing separators • Install a new external oil separator
Reduced pressure negatively impacts liquid delivery from high-pressure receiver to flooded accumulators	• Correct excessive line losses that may be occurring in under-sized liquid delivery piping • Install a pump on the liquid ammonia line from the high-pressure receiver to boost pressure
Existing thermal expansion valves are designed for minimum pressure ratio and will not operate properly at reduced pressure (for direct-expansion evaporators)	• Upgrade thermal expansion valves to electronic or motorized versions, which require less pressure differential • Install pressure booster pump on the liquid ammonia line • Replace direct-expansion evaporators with flooded/overfed evaporators

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

<table>
<tr><th colspan="3">Processing Infrastructure Efficiency</th></tr>
<tr><td rowspan="3">Refrigeration and Process Cooling Systems</td><td>Tactic</td><td>Description</td></tr>
<tr><td>Preventive Maintenance</td><td>Implement preventive maintenance procedures in the following areas to maintain efficiency:

Compressors

Check pressure transducer calibration regularly
Check and maintain belt drives
Check functionality of unloading controls (slide valves on screw compressors; cylinder unloaders on reciprocating compressors)

Condensers

Clean spray nozzles and strainers and check for proper spray pattern
Check and remove accumulation on tube bundles and/or air flow baffles
Check and maintain belt drives
Maintain water quality to prevent scaling and biological growth
Check for non-condensable gas accumulation and that purging equipment is functioning properly

Evaporators

Check and clean evaporator coils
Check liquid and gas valves regularly for proper functioning
Calibrate temperature sensors routinely

Heat exchange
Compressed air systems
Pasteurization process
Material handling and conveying systems
Hydraulic systems
CIP efficiency/optimization

Maintain filters to prevent excessive pressure loss
Ensure refrigerant is charged properly
</td></tr>
<tr><td>VFD-Control</td><td>Consider upgrading a screw compressor to VFD-control and operating as the load trimming unit. Selecting a compressor for VFD-control should be determined on relative sizes of the compressors and typical load variations. The compressor should be large enough to prevent frequent cycling of other compressors and should be capable of handling typical load variation via speed control. Consult the compressor manufacturer regarding retrofitting, including minimum and maximum speed capabilities, and motor recommendations.

Also, consider improving condenser efficiency and condensing pressure variability by implementing VFD-control for condenser fans. Due to fan affinity laws, power consumed by fans drops significantly when speed decreases, and it is typically advantageous to operate several condensers wet and with VFD-controlled fans simultaneously running at mid-range speeds. VFD-control also reduces belt wear and results in less noise at reduced speeds.

Look into installing VFDs on condenser water pumps or trimming pump impellers to avoid excessive pumping rates.</td></tr>
<tr><td colspan="3">Processing Infrastructure Efficiency Tools and Resources</td></tr>
<tr><td colspan="3">
Energy Efficiency Improvement and Cost Saving Opportunities for the Dairy Processing Industry, https://bit.ly/3uCXmGs
Low-GWP Refrigerants and How it is Affecting the HVAC Industry, https://bit.ly/3GH6ThZ
Transitioning to Low-GWP Alternatives in Commercial Refrigeration, https://bit.ly/3LITK1s
ENERGY STAR Focus on Energy Efficiency in Dairy Processing, https://bit.ly/3sy8dP7
Database of State Incentives for Renewables & Efficiency (DSIRE), https://bit.ly/3rFYffB
</td></tr>
</table>

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Product Hauling and Distribution Fleet

Note: Some topics in this section only apply if the processor owns its product hauling/distribution fleet. It may be challenging to implement changes such as fleet electrification and truck retrofits if the processor contracts a third-party organization to haul its products, rather than owning and operating its own fleet.

Tactic	Description
Distribution Network Optimization	Where possible, connect and collaborate with suppliers and/or customers to implement practices to optimize both inbound and outbound transportation networks. Practices that may contribute to this include: • Shipment pooling – When several "less than load" (LTL) orders are destined for the same geographic area, they can be combined to create one full truckload to a central region hub. Then, LTL distribution can be shipped from the central hub over much shorter distances. • Shipment aggregation – If not done so already, create a single shipment out of multiple orders that are destined for the same customer, but would otherwise be released as separate shipments. • Shipment consolidation – Combining multiple LTL orders with a truckload-sized order that is not at full capacity to be delivered as part of a stop-off route on the way to the destination. • Minimize empty milage – Where possible, capitalize on opportunities to fill trucks that otherwise would have been empty (already made their delivery).
Fleet Efficiency Technologies and Practices	Consider upgrading/retrofitting trucks with technologies and practices that improve hauling efficiency and enable trucks to travel further distances using less fuel. Examples of such technologies and practices include: • Trailer fairings/skirts • Adding boat tails • Engine down-speeding • Implementing automated manual transmissions (AMTs) • Sealing the tractor/trailer gap
Fleet Electrification	Consider replacing distribution and delivery vans/smaller trucks with 100 percent electric, or hybrid alternatives. Although the upfront cost may be more expensive than traditional gasoline or diesel-powered vehicles, the cost savings over their service lifetime will more than offset it due to less required maintenance and avoided fuel costs. Electric freight trucks can be considered as well, although technology is still in its infancy and mass production is still likely several years away.
Forklift Electrification	Consider replacing gas-powered forklifts with electric forklifts if not done so already. Although the upfront investment is more, electric forklifts have a lower maintenance cost than gas-powered forklifts, ultimately saving money over the lifetime.
Renewable Fuels	Consider replacing distribution and delivery fleets with renewable natural gas (RNG) powered trucks and vans. If purchasing new vehicles is an unfeasible option, programs exist for leasing new RNG powered vehicles, such as Clean Energy's Zero Now program. Furthermore, fueling a fleet with RNG is an excellent opportunity to create a circular economy with dairy farmers, and potentially lower supply chain GHG emissions by sourcing RNG from the same farms that supply a processor with milk (if possible). This inherently lowers processors' Scope 1 GHG footprint (due to reduced fleet emissions) and Scope 3 footprint (due to the supplier farmers' lowered Scope 1 GHG footprint from improved manure management practices). Other renewable fuel options to consider that significantly lower fleet-related emissions besides RNG include biodiesel (which burns cleaner than traditional diesel) and hydrogen.

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Product Hauling and Distribution Fleet

Product Hauling and Distribution Fleet

Tools and Resources

- EPA SmartWay, https://bit.ly/34NwGYw: EPA program that helps companies advance supply chain sustainability by measuring, benchmarking and improving freight transportation efficiency.
- North American Council for Freight Efficiency, https://bit.ly/3GTWSOR: Works to drive the development and adoption of efficiency enhancing, environmentally beneficial, and cost-effective technologies, services and methodologies in the North American freight industry.
- NACFE Trailer Fairings, https://bit.ly/3BaJpAS: NACFE information on the benefits, challenges, strategies, and decision-making tools associated with trailer fairings and aerodynamics.
- Freight Wing and Aerodynamic Fairings, https://bit.ly/3rGL9ic: Information from the Office of Energy Efficiency and Renewable Energy on the benefits of freight wings and aerodynamic fairings, including energy, GHG emissions and other pollutant savings.
- ICCT Heavy Duty Vehicles, https://bit.ly/3BaGuIi: Independent nonprofit organization founded to provide first-rate, unbiased research and technical and scientific analysis to environmental regulators.
- GlobalTranz 5 Transportation Management Optimization Practices, https://bit.ly/3oDCWcu: Provides five strategies to optimize freight transportation to improve sustainability and reduce costs.
- Electric vs. Gas-Fueled Forklifts, https://bit.ly/33b2c2e: A comparison of electric and gas-fueled forklifts including the functional advantages and disadvantages of each, and long-term costs.

Renewable Energy Options

Renewable Energy Options

Procuring renewable energy is an excellent way to significantly lower a company's GHG footprint, often at a competitive cost compared to traditional energy technologies such as natural gas, oil, and coal. There are a variety of renewable energy purchasing options and structures that provide companies with carbon-free electricity to run their operations. Purchasing decisions may vary depending on several factors, such as state utility regulation/deregulation and geography. Some of the most common renewable energy purchasing options are detailed below.

Tactic	Description
Biogas	Biogas is a valuable byproduct of decomposing animal waste in livestock operations, processing byproducts, and food waste, and it is produced when the organic components decompose anaerobically (in the absence of oxygen) in a digester. Dairy processors are uniquely positioned to create a circular economy within their supply chains by purchasing biogas generated from their supplier farms to power their facilities and operations. Biogas can be used as a direct fuel source for heating, boilers, chillers, and drying, or upgraded to a cleaner gas and used as vehicle fuel and/or used as feedstock for natural gas pipelines. It can also be combusted in an engine generator to produce electricity, which can power operations, or be sold to the electric grid. Additionally, waste heat from the engine generator set can be captured in cogeneration power systems and used for heating water or space heating.
Community Solar/Wind	Community solar/wind projects are large, shared solar photovoltaic (PV) systems, or wind turbines that are located away from the off-taker's facility. Customers of a community solar/wind project would subscribe to a portion of the generation from the project to match their electricity demand. These projects deliver electricity to the grid, and subscribers can claim renewable energy credits (RECs) associated with their electricity usage.

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Renewable Energy Options

Renewable Energy Options

Tactic	Description
Green Power Programs	Green power programs are optional service products for customers to purchase renewable energy offered by their local utility in regulated retail markets or a third-party supplier in competitive retail markets. Opting into a green power product allows the customer to purchase RECs associated with the physical electricity delivered to their facilities.
Onsite Solar	Also known as "behind-the-meter" solar, onsite solar is a solar system installed on an organization's property either on a building rooftop, over a parking lot, or on the ground. Electricity from onsite solar systems directly powers the facility and can be sold to the grid. Onsite solar systems can be purchased outright, or financed through purchasing structures such as leasing, and physical power purchase agreements (PPAs).
Virtual Power Purchase Agreements (VPPAs)	A corporate virtual power purchase agreement is a financial contract between an off-taker and a third-party renewable energy developer where the off-taker agrees to purchase a renewable energy project's output and associated RECs at a fixed rate. The developer then sells the energy at wholesale market pricing and passes the revenue through to the off-taker. The off-taker retains all the RECs associated with the delivered energy, so long as it's specified in the contract.

Tools and Resources

- Clean Energy Buyers Alliance (CEBA), https://bit.ly/3Jh8Cfz: Membership association for energy customers seeking to procure clean energy across the U.S.
- Department of Energy, https://bit.ly/3BgKUO2: Information on various forms of clean and renewable energy.
- EPA Clean Energy Programs, https://bit.ly/3GERiPV
- Database of State Incentives for Renewables & Efficiency (DSIRE), https://bit.ly/3rFYffB: Comprehensive information on incentives and policies that support renewables and energy efficiency in the United States.
- Green-e, https://bit.ly/364U5FH: Program that provides businesses and individuals with certified, verified clean energy.
- RE100, https://bit.ly/3rF74Gk: Global corporate renewable energy initiative bringing together hundreds of large and ambitious businesses committed to 100 percent renewable electricity.

Carbon Offsetting and Carbon Markets

Carbon Offsetting

Carbon offsetting is the practice of reducing GHG emissions – or increasing carbon storage – outside of a company's supply chain in order to compensate for emissions that occur within a company's supply chain and/or direct operations. Carbon offsets are quantified as carbon offset credits, which are tradable assets certified by governments or independent certification bodies. One offset credit is equal to the reduction of one metric tonne of carbon dioxide equivalent (CO_2e).

Although there are many strategies, technologies and practices that can help dairy processors lower their GHG footprint, there are inevitably sources of emissions that are impossible to abate. Therefore, dairy processors can purchase carbon offset credits and retire them to claim the associated GHG emissions reductions and neutralize the emissions arising from the non-abatable sources. It is important to emphasize that processors should prioritize mitigating and reducing emissions within their operations and supply chain before purchasing carbon offset credits. Simply purchasing offset credits to neutralize a company's emissions without actually pursuing strategies to reduce its footprint is poor practice, and would likely be met with scrutiny in the marketplace.

There is a variety of companies and organizations that sell carbon offset credits, but not all credits are the same. There are several factors that influence the quality of an offset credit. If looking to purchase offset credits, processors should vet the credits for the following attributes to ensure they are high quality.

GHG Reduction Opportunities within Operational Control (Scope 1 and 2)

Carbon Offsetting and Carbon Markets

Carbon Offsetting

Attribute	Description
Additional	GHG reductions are additional if they would not have occurred in the absence of a market for offset credits. In other words, if the reductions would have happened regardless of whether a market existed or not, additionality is not achieved.
Not Overestimated	Ensuring that emissions offsets are not overestimated is crucial. Companies can ensure the offset credits they are purchasing are not overestimated by confirming that the project they are derived from is verified. Overestimating can occur in four distinct ways: • Overestimating baseline emissions from a project • Underestimating actual emissions from a project after it has been implemented • Failing to account for indirect emissions resulting from a project (also known as "leakage") • Forward crediting a project that has not happened yet, but is expected to be implemented
Permanent	Since CO_2 is very long-lived in the atmosphere, offset projects must achieve sequestration timelines of similar length (hundreds to thousands of years).
Not Double-Claimed/ Counted	Offset credits must convey an exclusive claim to GHG reductions. Companies should ensure that the offset credits they are purchasing are: • Not issued to another organization in addition to their own (double issuance) • Not counted by another organization towards their GHG reduction goals (double counting) • Not claimed by another organization towards their GHG reduction goals (double claiming)
Not Associated with Significant Social or Environmental Tradeoffs	Offset projects should not significantly contribute to social and/or environmental harms as a side effect of reducing GHG emissions.

There are two distinct types of carbon markets – compliance and voluntary. Compliance market schemes are created and regulated by mandatory national, regional, or international carbon reduction initiatives. Alternatively, voluntary markets exist outside of compliance markets, and enable companies to purchase offsets voluntarily. Voluntary offset credits do not fulfill compliance market credits.

Attribute	Description
Carbon Markets	Examples of major U.S.-based offset programs are included below: Compliance: • California Compliance Offset Program (California) • Regional Greenhouse Gas Initiative (RGGI) (Northeastern U.S.) Voluntary: • American Carbon Registry • The Gold Standard • Climate Action Reserve (CAR) • Plan Vivo • The Verified Carbon Standard (Verra) • Truterra

Tools and Resources

- Carbon Offset Guide, https://bit.ly/3Bes4Hd: Guide for companies and organizations seeking to understand carbon offsets and how to use them in voluntary GHG reduction strategies.

GHG Reduction Opportunities within the Supply Chain (Scope 3)

<table>
<tr><th colspan="3">Packaging</th></tr>
<tr><td rowspan="7">Reducing Packaging-Related Emissions</td><td colspan="2">Dairy processors can implement strategies within their packaging portfolio – both upstream and downstream in the supply chain – to ultimately lower their GHG footprint. These strategies may also have co-benefits to help processors achieve recyclability and waste goals as well. Furthermore, several states have introduced new packaging policies with more stringent requirements, and more states are likely to follow in the next three to five years. Therefore, implementing these strategies now to get ahead of the curve will help processors avoid potential financial and regulatory risks associated with meeting new packaging mandates. Additionally, many retailers are setting ambitious packaging and recycling goals, so processors that sell to these retailers may be able to reduce their packaging-related emissions while simultaneously aligning with these commitments.</td></tr>
<tr><td>Tactic</td><td>Description</td></tr>
<tr><td>Label Communication</td><td>Processors can use their product labeling to communicate to consumers whether the packaging can be recycled, and if so, how to properly recycle it in residential recycling programs. Additionally, processors can partner with NGOs such as How2Recycle, which provides a standardized labeling system that clearly communicates recycling instructions to the public. Taking efforts to ensure packaging is recycled ultimately lowers GHG emissions associated with the end-of-life treatment of sold products.</td></tr>
<tr><td>Packaging Footprint</td><td>Developing a packaging footprint for all intermediate and final products can help processors create a baseline of their packaging materials and volumes and allow them to fully understand the current impacts of their packaging. This baseline can also be useful for setting time-bound, quantifiable goals to improve on the packaging impacts and GHG-related impacts from packaging.</td></tr>
<tr><td>Packaging Reduction</td><td>Another simple strategy to reduce packaging-related GHG emissions is to reduce the material used in product packaging to begin with. Identifying the minimum amount of packaging necessary, while ensuring that food quality and safety is not compromised, will ultimately lower the amount of packaging needed, and the emissions associated with that packaging.</td></tr>
<tr><td>Post-Consumer Recycled Content (PCR)</td><td>Post-consumer recycled content is material that is recovered after the consumer has used it, and is recycled and reintroduced into the packaging material supply. Processors can purchase packaging such as bottles, cans and tubs with PCR content, although demand in the U.S. market is high and supply is limited. However, sourcing PCR packaging can help companies lower their Scope 3 GHG footprint by avoiding emissions associated with manufacturing virgin packaging materials.</td></tr>
<tr><td>Recyclable/ Compostable Packaging</td><td>Sourcing product packaging that can be easily and readily recycled and/or composted after consumer use is another strategy to lower packaging-related emissions. It is important to note that processors should prioritize making their product packaging recyclable rather than compostable, as the infrastructure needed for industrial and commercial composting is not consistently available across the U.S. The following materials are typically accepted in residential recycling programs:
• High-density polyethylene (HDPE)
• Polypropylene (PP)
• Polyethylene terephthalate (PET)
• Aluminum
• Paperboard and corrugate</td></tr>
</table>

GHG Reduction Opportunities within the Supply Chain (Scope 3)

Packaging

Reducing Packaging-Related Emissions

Tools and Resources

- Sustainable Packaging Coalition, https://bit.ly/3szlqXY: Membership-based collaborative that believes in the power of industry to make packaging more sustainable.
- Ellen MacArthur Foundation, https://bit.ly/3szlqXY: Charity committed to creating a circular economy, which is designed to eliminate waste and pollution, circulate products and materials, and regenerate nature.
- How2Recycle, https://bit.ly/3uM5Qv7: Standardized labeling system that clearly communicates recycling instructions to the public.
- Closed Loop Partners, https://bit.ly/3JkighO: Investment firm comprised of venture capital, growth equity, private equity and project finance focused on positive social and environmental impact by reducing waste and greenhouse gas emissions via materials innovation, advanced recycling technologies, supply chain optimization and landfill diversion.
- The Recycling Partnership, https://bit.ly/3HLXF5u: Catalyzes improvements through leveraged seed grants, partnerships and extensive reach to spark commitment, investment and standards.
- Institute of Scrap Recycling Industries (ISRI), https://bit.ly/3HXEu97: Promotes safe, economically sustainable and environmentally responsible recycling through networking, advocacy and education.

The U.S. Dairy Net Zero Initiative

On-Farm GHG Reduction Strategies

Launched in 2020, the U.S. Dairy Net Zero Initiative (NZI) is an industry-wide effort to accelerate voluntary action on farms to reduce environmental impacts by making sustainable practices and technologies more accessible and affordable to U.S. dairy farms of all sizes and geographies. Almost universally, the largest source of processors' supply chain (Scope 3) GHG footprint arises from on-farm emissions from their suppliers' farms and/or direct ship farms. Therefore, engaging in the work of NZI to identify and pursue mutually beneficial practices and technologies that reduce on-farm GHG emissions is an excellent way to address the most significant source of supply chain emissions.

Workstream	Description
Groundwork	Provides foundational science to increase what is known, fill in data gaps, improve the models used to estimate improvements, and identify areas for the largest potential impacts.
Dairy Scale for Good	Focused on implementing the full suite of best practices and technologies on 3-5 farms across the country to prove the economic viability of reaching on-farm net zero GHG emissions.
Collective Impact	Supports broad, voluntary farmer adoption of proven best practices, technologies, and combinations of both. To achieve solutions at scale, Collective Impact will increase awareness of technical assistance, financial support opportunities and more.

GHG Reduction Opportunities within the Supply Chain (Scope 3)

On-Farm GHG Reduction Strategies

The U.S. Dairy Net Zero Initiative

To ensure NZI is a success, support, resources and funding are needed from the entire dairy value chain. There are several customer partners (e.g., Starbucks and Nestle), NGO partners (e.g., The Nature Conservancy and American Farmland Trust) and government organizations (e.g., Foundation for Food and Agriculture Research and the Wisconsin Department of Agriculture) already supporting our efforts, but we have a long way to go.

At present, there are several channels through which dairy processors can engage, financially or otherwise, in the work of NZI to reduce their supply chain GHG emissions.

Channel	Description
Groundwork	• Support the Dairy Soil and Water Regeneration projects with required matching funds/resources to reduce GHGs, improve water quality and unlock new economic benefits (~$300,000 annually) • Join the Greener Cattle Initiative (GCI) to advance research on enteric methane mitigation (cost TBD) • Support efforts to identify and engage farms in your region to complete necessary research • Dedicate on-staff technical experts to advance research and test workplans
Collective Impact	• Join an existing Collective Impact project to support reporting and storytelling efforts (~$50,000) • Identify partners in your region for the expansion of existing projects to new geographies (~$100,000+) • Invest needed funding to support soil health curriculum development for Certified Crop Advisors (~$50,000) • Engage your customers in paving the way to the 2050 Environmental Stewardship Goals through NZI involvement • *For additional information, and/or to get involved, contact Jennifer Block (Jennifer.Block@dairy.org) at the Innovation Center for U.S. Dairy.*

Tools and Resources

- Newtrient Technology Catalog, https://bit.ly/2TOoh1w: Provides all dairy farmers with information regarding technologies that meet their farm's unique needs for manure and nutrient management and their own unique business goals.
- The U.S. Dairy Net Zero Initiative, https://bit.ly/3gTZm5f: Information brief on the U.S. Dairy Net Zero Initiative.
- Institute for Feed Education & Research, https://bit.ly/3spvrHi: Advances understanding and trust in a sustainable animal feed and pet food supply chain through timely research and education.

GHG Reduction Opportunities within the Supply Chain (Scope 3)

Waste

Reducing Waste-Related GHG Emissions

Dairy processors can further reduce their supply chain GHG emissions by identifying, mitigating, and/or repurposing their waste streams. Organic waste in particular is a large source of methane emissions when it decomposes, so taking measures to reduce this emissions source can be particularly beneficial towards reducing GHG footprints.

Tactic	Description
Alternative Applications	Identifying alternative applications for would-be waste is another effective way to reduce waste-related GHG emissions. For example, a common byproduct in dairy processing is organic wastewater sludge. Wastewater sludge has several alternate applications, such as: • Land spreading on nearby agricultural fields as a source of fertilizer • Further processing for industrial fertilizers • Feedstock for anaerobic digesters There are various partnership and collaboration opportunities where dairy processors can repurpose their would-be waste. One such dairy-specific partnership is the Farm Powered Strategic Alliance, a collaboration between Starbucks, Dairy Farmers of America, Unilever, and Vanguard Renewables. This initiative redirects food waste to on-farm anaerobic digesters to generate renewable natural gas (RNG), thus creating a dairy supply chain circular economy.
Waste Audits	A waste audit is a survey of a facility's waste stream. Once a more detailed analysis of waste streams is understood, processors can reveal opportunities to divert and reduce various sources of waste, ultimately lowering waste-related GHG emissions. Waste audits provide several other benefits as well, such as: • Identifying inefficiencies in waste handling • Saving money through identification of new revenue streams and reduced waste hauling costs • Setting a baseline and measuring improvement over time • Meeting certification standards (e.g., LEED) • Obtaining accurate data for sustainability reporting purposes (e.g., CDP, Project Gigaton) Furthermore, through the Innovation Center's Processor Working Group, the Waste Subcommittee is currently developing a dairy processor-focused Waste Audit Template to provide guidance on conducting a waste audit in a dairy processing facility. This guidance is scheduled for launch in 2022.

Tools and Resources

- EPA Waste Reduction Model (WARM), https://bit.ly/34Nw85d: EPA tool to help solid waste planners and organizations track and voluntarily report GHG emissions reductions, energy savings, and economic impacts from several different waste management practices.
- Farm Powered Strategic Alliance, https://bit.ly/3gAADCP: Collaborative movement to boost food waste reduction and recycling, and expand renewable energy production across America.
- Recycle Coach – How to Do a Waste Audit for Your Company, https://bit.ly/3LpFG79: General information on how to conduct a waste audit for a company or organization.
- RoadRunner Waste Management, https://bit.ly/3BdAcaW: Provides technology through an urban logistics engine to recycle more as safely, efficiently and environmentally friendly as possible.

GHG Reduction Opportunities within the Supply Chain (Scope 3)

GHG Reduction Target Setting

Science-Based Targets and The Science Based Targets Initiative

The Science Based Targets Initiative (SBTi) is a collaboration between CDP, the U.N. Global Compact, the World Resources Institute (WRI) and the World Wildlife Fund (WWF). Started in 2015 as a result of the Paris Agreement, SBTi defines and promotes the best practices in emissions reductions and net zero targets in line with climate science. Further, SBTi develops methodologies and resources that over 2,000 companies have utilized to set science-based targets. A GHG reduction target is considered "science-based" if it is developed in line with the scale of GHG emissions reductions required to limit global warming to 1.5˚C above pre-industrial levels. Science-based targets are currently the most credible and accepted pathway for the corporate sector to set GHG reduction targets.

The SBTi is currently developing the Forest, Land and Agriculture (FLAG) pathway for companies in land-intensive sectors, such as dairy. Although many companies in this sector have SBTs already, many do not account for and report agricultural, forestry, and land use (AFOLU) related emissions. FLAG addresses this gap by providing methods and guidance to enable businesses within this sector to fully incorporate deforestation and land-related emissions into their targets. The FLAG methodology will have a pathway for companies specifically in the dairy supply chain, and is currently scheduled for release at the end of Q1 2022.

Setting a Science-Based Target

Companies in the food and beverage sector, both processors and retailers, that have already set or committed to set a science-based target (as of January 2022) include:

- Arla Foods
- Ahold Delhaize
- Albertsons
- Aldi
- Amazon
- Ben & Jerry's
- Chobani
- Coca-Cola
- Conagra
- Danone
- Dairy Farmers of America
- Fonterra
- General Mills
- Glanbia Nutritionals
- Nestle
- PepsiCo
- Schreiber Foods
- Stonyfield Farm
- Target
- United Natural Foods Inc.
- Unilever
- Walmart

Additionally, some companies are implementing science-based reduction targets for their suppliers as well. For example, Target has committed to have "80 percent of their suppliers, determined by spend, set science-based reduction targets on their Scope 1 and 2 emissions by 2023." Other large retailers are likely to implement similar goals soon.

Tools and Resources

- SBTi How-To Guide, https://bit.ly/3oEs2U6: A guide to assist companies in where to start when setting science-based targets.
- SBTi Corporate Manual, https://bit.ly/366uhsL: Step-by-step guide for companies to set science-based targets, and ensure they are in compliance with the requirements of measuring and reporting against an SBT over time.
- SBTi Criteria, https://bit.ly/35SFdKj: Criteria which must be met in order for GHG reduction targets to be recognized by the SBTi.
- Target Setting Tool, https://bit.ly/3gAwpLg: Excel-based tool to enable companies to develop appropriate science-based emission reduction targets, and to assist companies and interested third parties in assessing and evaluating companies' targets.
- SBTi Net Zero Standard, https://bit.ly/3GAN0cs: Provides guidance, criteria, and recommendations to support corporations in setting net-zero GHG reduction targets through the SBTi.

About the Innovation Center for U.S. Dairy®

The Innovation Center for U.S. Dairy® is a forum that brings together the dairy community to address the changing needs and expectations of consumers through a framework of shared best practices and accountability. Initiated in 2008 by dairy farmers through the dairy checkoff, we collaborate on efforts that are important both to us and our valued customers — in areas like animal care, food safety, nutrition and health, the environment and community contributions.

Through the Innovation Center, the U.S. dairy community demonstrates its commitment to continuous improvement from farm to table, striving to ensure a socially responsible and economically viable dairy community. Learn more at www.USDairy.com.

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