skyventechnologies

case study

DECARBONIZE PROFITABLY

Clean Thermal Energy for Dairy

CLIENT: CALIFORNIA DAIRIES, INC (CDI)

Industrial, a dairy processing cooperative

California

In progress

PROJECT HIGHLIGHTS

MMBTUs saved: 223,000 MMBTU of natural gas annually

CO2 saved: 12,000 metric tons

CAPEX: zero, pay-per-btu at 20% discount off natural gas price.

Grants: Skyven wrote and won 5 grant and state incentives on behalf of CDI, totaling ~$12M.

> ***Our ground-breaking project with Skyven is going to save the company money on fuel and substantially reduce our CO2 emissions, paving our path towards a cleaner future***

Darrin Monteiro, Director of Government Relations, CDI

SKYVEN'S MISSION

Skyven Technologies is on a mission to stop climate change by making it easy and profitable for industrials to eliminate carbon emissions caused by process heat. Our goal is to help every facility that we work with to achieve zero scope one GHG emissions from thermal energy in under a decade.

CLIENT BACKGROUND

California Dairies, Inc. (CDI) is the largest member-owned milk marketing and processing cooperative in California producing 40% of California's milk, co-owned by nearly 400 dairy producers who ship 16 billion pounds of Real California Milk annually. CDI is a manufacturer of quality butter, fluid milk products and milk powders, operating seven dairy processing plants in the State of California. In addition, CDI is the home of two leading and well-respected brands of butter – Challenge and Danish Creamery. CDI's quality dairy products are available throughout the United States and in more than 50 foreign countries.

THE SKYVEN PROCESS

Skyven Technologies provides end-to-end services to develop thermal energy decarbonization projects for large industrial, commercial, and institutional facilities. Our services to CDI include project discovery, conceptual design, feasibility studies, design-build, operations and maintenance, and measurement and verification. Through proprietary analysis technology, a range of solutions (image below) were considered and only those that had the best fit for CDI's unique dairy processing operation were implemented.

CHILLERS
- Absorption
- Desuperheater
- Oil Cooler
- Compressor Heat Recovery

VAPOR RECOMPRESSION
- Mechanical
- Thermal

SEPARATION
- Membrane
- Reverse Osmosis
- Heat Catalyzed Separation

REGEN
- Clean in Place
- Pasteurization

CARBON CAPTURE

STEAM AND BOILER SYSTEM
- Blowdown Recovery
- Condensate Return
- Economizer
- Condensing Economizer
- Flash Steam
- Point of Use Generation
- Combustion Air Preheat
- Recuperator
- Waste Heat Boiler

RENEWABLES
- Biogas
- Biomass
- Geothermal
- Solar Thermal
- Renewable Natural Gas
- Renewable Grid Electricity
- Renewable Diesel

COMBINED HEAT AND POWER
- Reciprocating Engine
- Fuel Cell
- Turbine

DRYING AND EVAPORATION
- Additional Effects
- Microwave Vacuum
- Recovery for Pre-Heat
- Combustion Air Preheat
- Cooling Tower Heat Recovery

POWER GENERATION
- Back Pressure Turbine
- Condensate Return
- Organic Rankin Cycle

HYDROGEN

STAGE 1: OPTIONS STUDY

Skyven completed a data collection and energy assessment to identify opportunities for clean thermal energy that can be immediately implemented for optimal fuel savings and minimal risk. CDI provided PFDs, HMI screen caps, and historian data, which the Skyven team used to provide estimates of fuel savings, emissions reductions, a rough schedule, and a risk mitigation strategy. Eight decarbonization project opportunities were proposed by Skyven and reviewed with CDI's engineering team, as shown below. Out of these, six projects proceeded to the next stage for a deeper investigation.

STAGE 2: FEASIBILITY STUDY

Skyven performed multiple site visits to provide a feasibility study, composed of a basic engineering study (FEL-2) with a cost-benefit analysis of available products, installation options, and operational impacts on proposals #1-6 below. Proposal #7-8 were ruled out pre-feasibility study. The Skyven team paid specific attention to operations concerns raised by the plant staff, gathering input from equipment vendors and/or EPCs as needed for project scoping. Risk analysis and contingency planning was performed to provide a comprehensive project schedule and plan to minimize downtime and plant resource requirement.

Feasibility Study (FEL-2) Deliverables

Engineering

- Heat and Material Balances
- Process Flow Diagram with stream summary
- Preliminary P&ID Drawings, for new equipment and new tie ins only
- Tie-In List
- Line List
- Major manual Valve List
- Major Control Valve List
- Instrument List
- Pump and Motor List
- Preliminary Thermal insulation specification
- Preliminary sizing for major Control Valves and Instruments
- Sizing, specifications, and datasheets for major equipment, including pumps, compressors, heat exchangers, vessels, gensets, and HRSGs
- Control System Narrative includes description of safety interlocks
- Vessel weights, empty, operating and flooded.
- General Arrangement Drawings for new equipment and large bore pipe
- Preliminary piping layouts
- Preliminary structural details, foundation design and civil engineering analysis
- Preliminary electrical one-line diagrams

Execution and Management

- FEL 2 Overall Project Cost Estimate
- Capital Cost Estimate
- Operating Cost Estimate
- Project execution plan (early deliverable)
- Proposed engineering specifications (high level only)
- Project risk register (high level only)

The following was presented to CDI's engineering team to implement at two of CDI's facilities in central California:

Project	Options Study Description	Feasibility Study Results
1. Condensing Economizers	Proposed to be used for preheating boiler feed water with heat from boiler exhaust. Condensing economizers use heat from boiler flue gas to heat water. They partially condense the water vapor in the flue gas, capturing the heat of vaporization that would otherwise be trapped in the flue gas. A condensing economizer will be installed on the boiler flue downstream of the traditional (non-condensing) economizer.	• Established physical location of equipment including structural feasibility • Validated available energy • Validated thermal load to be serviced • Increased fidelity on cost estimate
2. Renewables, Solar Thermal	Proposed a latest generation solar process heating technology specialized for industrial applications to reduce fossil fuel consumption at two CDI locations. Skyven determined multiple potential uses for this heat, for example to pre-heat dryer air. An array of 2000 solar collectors was sized for the roof of one plant, and 3000 solar collectors was sized for the ground of the second.	• Confirmed structural integrity of the roof • Validated thermal load to be serviced • Validated system sizing • Increased fidelity on cost estimate
3. Latent heat recovery from the evaporator	Proposed to redirect heat from the evaporator condenser to heat COW water being used for cleaning and reduce the cooling load of the cooling tower.	• Validated that the evaporation process will be unaffected by the project • Addressed concerns of microbial activity • Validated space constraints • Increased fidelity on cost estimate
4. Dryer Heat Recovery	Dryer heat recovery uses the warm exhaust from the spray dryers to preheat the intake air on the dryers. At CDI, Skyven proposed to preheat the intake air on the dryers. An air-to-water heat exchanger was investigated on the dryer exhaust, and another air-to-water heat exchanger was investigated on the air intake. A closed-circuit hot water loop will be plumbed between them to transfer heat.	• Established physical location of equipment including structural feasibility and space constraints • Confirmed structural integrity • Specified clean-in-place systems to prevent impact on product quality by creating a bypassable design per customer's concerns • Increased fidelity on cost estimate
5. Reverse osmosis of COW water	Reverse Osmosis (RO) refers to pressure driven membrane separation technique to separate different components in a fluid mixture, at CDI this was the COW water. Separation occurs based on molecular size and chemical interactions between the membrane and fluid components. Skyven identified the opportunity for pressure to be used to push COW water molecules through the pores of a membrane while retaining the colloidal milk solids, thus filtering COW water to be reused and not sent to drain (wasted).	• Confirmed electrical energy requirements • Investigated the need for additional water treatment steps to address biological activity • Increased fidelity on cost estimate
6. Condensate return	Proposed to capture condensate being dumped to the drain for use in boiler feed water and heating COW water, thus recovering thermal energy being wasted.	• Measured condensate flow rate • Refined estimates of thermal energy savings • Increased fidelity on cost estimate

Project	Options Study Description	Feasibility Study Results
7. Flash steam recovery	Proposed flash steam off the condensate flash vessel can be recovered and reused for heating purposes, such as heating warm water that has been used to preheat dryer air. This would help reduce/ eliminate the steam usage to heat up warm water and reduce natural gas consumption. Ruled out because quantification of flash steam and costs showed the project not to be economical nor would it yield significant energy savings.	N/A
8. Reverse osmosis of milk in feed	Similar to RO of COW water as described in item 5, RO of milk can be done as a preconcentration step. Whole milk can be concentrated with Reverse Osmosis (RO) to levels of 25-30% total solids (TS). Skyven proposed an option to reduce energy consumption in CDI's dairy evaporators. This project was ruled out due to product quality concerns and challenges with existing equipment and plant layout.	N/A

STAGE 3: IMPLEMENTATION

Once feasibility was established, Skyven provided pricing structures to execute the projects at no CAPEX to CDI. Under Skyven's Thermal Energy Services Agreement, Skyven is completing detailed engineering, project implementation, and operations and maintenance of the system at no upfront cost. In return, CDI purchases recovered BTU's harvested by the system at a discount to its actual fuel prices for a period of 10 years.

Additionally, using Skyven's expertise in clean energy policy, Skyven wrote and won 5 grant and state incentives on behalf of CDI, totaling roughly $12M.

Skyven is working with CDI to construct projects #1-6. Skyven is hiring and managing all contractors, freeing up CDI's capital projects team. As of May 2021, projects 1-3 are in the implementation phase, while projects #5-6 are undergoing detailed engineering. Project #4 has been halted due to operational concerns with the dryer.

STAGE 4: O&M WITH PERFORMANCE GUARANTEES

Post-implementation, Skyven stays on to ensure the project will operate as expected for 10 years. Skyven contractually guarantees project performance, so CDI can rest assured no system will be left behind.

> ***Skyven's expert team is joining together from different industries for a common purpose: to ensure that industrials realize meaningful savings and emissions reductions — year after year.***

Arun Gupta, Founder & CEO, Skyven Technologies