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Energy Efficiency and Demand Response

Additional submitted attachment is included below.

November 30th 2021

Via email to docket@energy.ca.gov

Re: Energy Efficiency and Demand Response in Industrial and Commercial Cold Storage Request for Information (Docket 19-ERDD-01)

To Whom it May Concern,

Cascade Energy appreciates this opportunity to provide written comments to help the California Energy Commission (CEC) identify target markets and research needs for energy efficiency and demand response in industrial and commercial cold storage facilities. We are an energy efficiency engineering and consulting firm based in the Pacific Northwest and have been a leading provider of services to the industrial sector since 1993. Our organization is dispersed across the United States, with 11 offices in eight states—including two offices in California—and our headquarters in Portland, Oregon.

Our company's expertise is in industrial sector refrigerated warehouses and cold storage facilities and therefore our response focuses on these customer types and not commercial grocers.

Research Needs

1. What are examples of advanced or noncommercially available energy efficiency control software packages applicable to refrigeration systems?

Cascade Energy maintains written design specifications that lists the capabilities of an efficient control system. A modern efficient control system includes energy submetering, dynamic pressure control, robust demand response, and load shifting capabilities.

2. Are there examples of commercial-scale desiccant dryers for refrigeration systems in use? If so, where and what is the application?

A few industrial scale facilities in the southern US use desiccant wheel type dryers to dehumidify air on cold docks and production freezers. These dryers are costly to operate compared to standard refrigeration-based reheat systems. We have also seen some examples of reheat and desiccant dryer units in food production spaces where humidity can become a problem, such as meat processing.

3. What are examples of retrofit waste heat recovery technologies for refrigeration systems that have been implemented in industrial and commercial cold-storage facilities?

Hot gas glycol heating for freezer floor freeze protection is common and industry standard in industrial settings. Compressor oil heat can also be recovered. We have seen waste heat used for pre-heating process water and boiler feedwater. A desuperheater on the compressor discharge can also recover waste heat. Desuperheaters are more common on reciprocating compressors than screw compressors.

Heat recovery from the discharge of the refrigeration system must be implemented carefully to avoid a net energy penalty. If the application sets the lower limit for condensing pressure, it lowers the efficiency of the refrigeration compressors. Modern ammonia refrigeration systems operate at a minimum discharge pressure of ~90 psig when ambient conditions allow, which only provides ~60 °F saturated refrigerant temperature.

4. What emerging technology advancements have the potential to meet the return-on-investment requirements of industrial and cold-storage facilities?
    - **Packaged condensing unit controllers**, which offer a short payback by cycling evaporator fans according to temperature and initiating defrosts based on runtime.
    - **Individual pallet blast freezing stations** with tight airflow control and automatic shut off.
    - **Bolt-on advanced control systems** with the following capabilities: dynamic system pressure control based on compressor/condenser or compressor/evaporator power-monitoring, demand response, and advanced flywheel control for load shifting.
    - **Electrically commutated (EC) fan motors**, which offer increased fan motor efficiency with speed control capability.
    - **Low-charge ammonia refrigeration systems or CO2-based systems**. These systems are not inherently more efficient than traditional central refrigeration systems, but they have the potential to reduce lifecycle costs associated with regulatory and safety requirements.
    - **Adiabatic condensers**, which can offer significant water savings over traditional evaporative condensers and are becoming more prevalent in areas with high water costs.
5. What are examples of best practices that could increase the energy efficiency of refrigeration systems that are not widely adopted?
    - **Load reduction measures** such as improved practice of keeping freezer forklift doors closed as much as possible. Today we often see doors left open during busy periods.
    - **Aggressive use of occupancy sensors** to shut off lighting. LEDs with occupancy sensors are now the norm, but the time delays are often set much longer than necessary.
    - **Systematic defrost optimization**. Today, defrost issues are often solved by increasing the number or duration of defrost cycles, rather than identifying the root cause of the problem.
    - **Grouped evaporator fan VFD control** has only been adopted by some control system vendors.
    - **Energy efficiency training**. Today, many refrigeration system operators do not have access to substantial refrigeration energy efficiency training.
    - Cascade Energy's "Industrial Refrigeration Best Practice Guide" lists many energy efficiency best practices.
6. Are there past or current cold-storage projects and related publications, proceedings, or reports you think the California Energy Commission should be aware of to target potential future solicitations?

Cascade Energy's "Industrial Refrigeration Best Practice Guide" lists many best energy efficiency best practices.

7. In which utility incentive or government programs (energy efficiency and demand response) do industrial and commercial cold-storage facilities generally participate?

They generally participate in Strategic Energy Management, Custom Capital Programs, and Retro-commissioning programs. Many facilities also participate in critical peak rebate demand response programs.

8. What electrical loads can be shifted in industrial and commercial cold-storage facilities? What incentives would encourage them to shift their electrical load? Do these facilities have the ability and possess the equipment to shift electrical load?

Refrigerated warehouse freezers have some ability to shift load by allowing air temperatures to float during peak periods, then running the refrigeration system harder during off-peak periods. This flywheel potential is largely dictated by the temperature specifications outlined in the facility's quality assurance guidelines and customer contracts. Facilities storing fresh produce, dairy, and meat have tighter temperature tolerances and are therefore unlikely to shift load in those rooms.

Higher financial incentives (on-peak energy and demand prices) will increase participation. Some facilities are well suited with adequate refrigeration equipment and controls in place. Some are poorly suited to shift because they lack the controls to appropriately sequence equipment. Another common barrier is a lack of training: operators may not understand the full system-wide impact of equipment-level load shifting decisions.

Forklift battery charging and freezer underfloor heating strategies and schedules can also be adjusted to shift electrical loads.

9. What research has been conducted on increasing thermal mass (e.g., adding thermal storage) within a cold-storage facility for greater demand response participation?

We know of one vendor: https://www.vikingcold.com/cold-storage/.

10. Has the current shift to online grocers affected the cold-storage economy? If so, how?

A large amount of online grocery fulfillment seems to be serviced through existing grocery retailers from the stores. The cold storage step in the cold chain does not seem like it has been significantly affected by this shift.

11. What are some of the major advanced technologies or strategies used to retrofit industrial and commercial cold-storage facilities to keep energy costs low? What are some of the barriers to their use? How can research help overcome these barriers?

VFDs are no longer considered advanced technologies but are still a powerful tool to retrofit in to cold storage facilities to improve efficiency. VFD retrofits are not yet universally adopted nationwide due to high retrofit costs. Good cold storage applications for VFDs include refrigeration compressors, condenser fans, and evaporators.

Advanced control retrofits can achieve energy savings without underlying equipment replacement if the legacy controls lacked key features such as compressor and condenser sequencing.

A key barrier to use, especially related to controls, is training. Many facilities lack trained refrigeration system operators, or do not have access to energy efficiency training curriculum for their operators. Untrained operators are less likely to run equipment efficiently. Some facilities rely on vendors to run their refrigeration system rather than internal staff. Vendors tend to have higher levels of training and efficiency knowledge, but they are typically less motivated by the facility's energy efficiency goals.

12. How often do industrial and commercial cold-storage facilities replace inefficient equipment with high-efficiency systems and improve system controls for energy efficiency or reducing cost?

Rarely. Most piecewise equipment changes are straight across replacements with no efficiency upgrades. If an entire refrigeration system is replaced outright due to R-22 phaseout issues or similar, the new system will likely be efficient due to California code. Outside of California, the replacements are also likely to have significant efficiency upgrades, depending on the owner.

13. What is the best way to communicate with industrial and commercial cold-storage facilities regarding energy-efficient and demand response technologies (for example, utility representatives, trade organizations)?
    - Trade groups, both national and through local chapters.
    - RETA and IIAR are two of the foremost organizations for industrial refrigeration.
    - Equipment vendors and refrigeration contractors.
    - Utility program reps have significant reach in mature incentive programs.
14. Are there any industrial and commercial cold-storage trade groups or committees that meet periodically to share information on energy-saving programs, technologies, and best practices? If so, what are their names and contact?
    - RETA
    - Global Cold Chain Alliance
    - NASRC
    - IIAR

Technology Status

1. Examples of technologies that could increase energy efficiency and load flexibility for industrial and commercial cold storage facilities include:
    - Advanced refrigeration systems (large interrelated systems bringing in variables such as product temperature, grid pricing, and thermal mass).
    - Artificial intelligence (AI)-based software and controls.
    - Advanced coatings on refrigeration/freezer coils to reduce defrost times.
    - Innovative moisture control methods to reduce cooling load (such as desiccant dryers, evaporators, or other energy-efficient means).
    - Thermal energy storage and controls to enable grid flexibility and participation in demand response programs.
    - Deployment of smart control systems and software to optimize system performance to increase energy efficiency, reduce operation and maintenance costs, reduce GHG emissions, and identify system refrigerant leaks and other equipment performance issues that affect equipment lifespan.
2. Are there any additional technologies that should be included and why?

Thermoacoustic refrigeration requires high temperature waste heat source or solar collectors. It is not yet close to being cost effective. Vacuum refrigeration systems (prevalent in vegetable/greens harvesting) can quickly cool large amounts of produce (high energy intensity for a short period). This technology could have application where there are high peaks of energy supply.

Performance Metrics

1. Metrics and performance indicators to evaluate new advanced technologies compared to current commercial equipment include:
    - Electrical energy savings (%).
    - Avoided/reduced maintenance costs ($).
    - Increased system efficiency (COP).
    - Load shift potential (kW/time).
    - Increases in cooling capacity (BTU).
    - Savings for the delivered end product ($).
    - Increase in system operability.
    - Greenhouse gas savings (MTCO2e).
    - Decrease in defrost intervals (time).
2. Should any of these be excluded and why?

The last bullet should be reworded to a decrease in defrost durations and/or increase in defrost intervals, where intervals refer to the time between defrost cycles.

3. Are there other performance indicators and metrics to consider and why?

Yes: kWh/unit product for blast freezing applications (product examples: pallet, hundredweight).

For central refrigeration systems, performance must be measured at the system level, not the equipment level, due to the interplay between system components. Cascade Energy frequently measures system-wide or facility-wide cold storage energy efficiency improvement using top-down linear regression modeling per IPMVP Option C and ASHRAE 14-2014 guidelines, using ambient conditions and facility throughput as key energy drivers.

Please feel free to contact me if I can provide any additional clarification on our response. Thank you again for this opportunity.

Sincerely,

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