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July 29, 2026

California Energy Commission
Docket No. 25-BSTD-03
715 P Street
Sacramento, California 95814

Re: Comments on the Proposed 2028 Energy Code Exception for Small Transcritical CO_2 Remote Condensing Units Title 24

Solstice Advanced Materials appreciates the opportunity to submit these comments on the California Energy Commission's (CEC's or the Commission's) 2028 Energy Code pre-rulemaking workshop materials for covered process refrigeration. Solstice is a leading global specialty materials company that advances science for smarter outcomes. Headquartered in New Jersey with leading research and development and manufacturing facilities across the United States, Solstice offers high-performance solutions that enable critical industries and applications, including refrigerants, semiconductor manufacturing, data center cooling, nuclear energy, protective fibers, healthcare packaging and more. Solstice supports California's continued efforts to improve building and covered-process energy efficiency through an open, technical, and data-driven standards-development process.

Background

During the June 24, 2026, workshop, CEC described a proposed exception to the existing transcritical CO_2 gas-cooler requirements in Sections 901.1.8 [120.6(a)8] and 902.1.5 [120.6(b)5]. As presented, the proposal would allow air-cooled gas coolers for refrigerated warehouses in Climate Zones 9 through 15 and for commercial refrigeration in Climate Zones 10 through 15, and CEC is seeking additional public input regarding thresholds for exception. The workshop materials state that the original analysis for the gas-cooler measure focused on larger systems and identify potential lower installation cost, lower maintenance cost, and lower water usage as expected benefits of allowing air-cooled gas coolers for the proposed small-system category.

Solstice is concerned with the lack of a quantified energy-impact analysis to undergird the proposed exception. The existing requirement addresses transcritical CO_2 performance in hotter climate zones, where gas-cooler heat rejection implementation can materially affect annual energy use. While the workshop materials present cost and water considerations, an exception to a mandatory efficiency requirement should also be evaluated for other factors such as annual electricity use, peak demand, lifecycle cost, and climate-zone-specific performance before the Commission moves forward with code revisions. Solstice respectfully requests that CEC develop and publish that analysis before finalizing the proposed exception.

Solstice Analysis of CO_2 Systems With and Without Adiabatic Cooling

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Solstice has performed an initial analysis of the same nominal equipment sizes reflected in the proposed exception, namely a 20-ton freezer system and a 40-ton cooler system at a 35 °C ambient condition. The analysis calculated Annual Walk-In Efficiency Factor, or AWEF, for a unit cooler paired with a dedicated condensing unit located outdoors using the procedure defined in ANSI/AHRI 1251-2025.[1] As required per the procedure, Kansas City, Missouri bin-temperature data was used for the AWEF calculation. The analysis compared CO_2 systems with and without adiabatic cooling against an R-454C baseline and modeled both medium-temperature cooler and low-temperature freezer applications. Although this analysis should be supplemented with California climate-zone-specific modeling before CEC makes a final policy decision, it is directly relevant because it evaluates the same 20-ton freezer and 40-ton cooler size thresholds identified in the proposed exception.

The Solstice analysis indicates that eliminating the adiabatic-cooling requirement for these small CO_2 systems would create a material energy penalty. In the AWEF comparison, the R-454C baseline is indexed to 100 percent for both the cooler and freezer cases. CO_2 with adiabatic cooling achieves about 82 percent of the R-454C AWEF in both the cooler and freezer cases, while CO_2 without adiabatic cooling achieves only about 72 percent in in both the cooler and freezer cases. Stated another way, adiabatic cooling improves the modeled CO_2 AWEF by about 10 percentage points in both the cooler and freezer cases relative to the same CO_2 system without adiabatic cooling.

The annual electricity results show the same concern. In the cooler case, CO_2 with adiabatic cooling consumes an additional 26,915 kWh per year relative to the R-454C baseline, while CO_2 without adiabatic cooling consumes an additional 46,775 kWh per year relative to that baseline. The difference between those two CO_2 cases is 19,860 kWh per year for the 40-ton cooler system, which represents approximately 74 percent more incremental electricity consumption when adiabatic cooling is removed. In the freezer case, CO_2 with adiabatic cooling consumes an additional 45,706 kWh per year relative to the R-454C baseline, while CO_2 without adiabatic cooling consumes an additional 68,340 kWh per year relative to that baseline. The difference between those two CO_2 cases is 22,634 kWh per year for the 20-ton freezer system, which represents approximately 50 percent more incremental electricity consumption when adiabatic cooling is removed.

These results do not mean that installation cost, maintenance cost, or water use should be ignored. They do show, however, that those factors should be evaluated together with electricity impacts before CEC creates a categorical exception for the affected size range. A complete evaluation should examine whether lower first cost and lower water use are offset by higher annual energy consumption, higher operating costs, increased peak demand, or reduced lifecycle energy savings

[1] AHRI Standard 1251-2025, Performance Rating of Walk-in Coolers and Freezers, 2025, Air Conditioning, Heating, and Refrigeration Institute, 2311 Wilson Blvd., Suite 400, Arlington, VA 22201, USA.

in the affected California climate zones. That evaluation should also consider whether alternative compliance pathways can preserve flexibility while maintaining comparable energy performance.

Solstice respectfully recommends that CEC not rely solely on system size as the basis for the proposed exception. If CEC determines that some compliance flexibility is warranted for smaller transcritical CO_2 remote condensing units, the exception should be supported by a California-specific study and should be structured to avoid unintended energy penalties. For example, CEC could evaluate whether an alternative pathway should require demonstration of equivalent or better annual energy performance compared with a compliant adiabatic gas-cooler configuration in the applicable climate zone. CEC could also evaluate whether any exception should be limited by quantified performance criteria, measured or modeled AWEF, seasonal energy use, peak demand, or other metrics that directly address the energy consequences of the proposed change.

Conclusion

Solstice appreciates CEC's willingness to seek stakeholder input during the pre-rulemaking phase. Solstice would welcome the opportunity to work with CEC staff and other stakeholders to refine the assumptions, perform California climate-zone modeling, evaluate water-energy tradeoffs, and develop code language that provides appropriate flexibility without sacrificing energy efficiency.

Sincerely,

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Appendix A: Assumption and Results from Solstice Analysis

Table A-1 summarizes the operating parameters of the freezer with a dedicated condensing unit located outdoors

Table A-1

Refrigerant	Mean Evaporating temperature	Suction temperature	Condenser air entering temperature	Mean condensing temperature difference (subcritical)	Subcooling (subcritical)	Gas cooler approach temperature (transcritical)	Isentropic Efficiency	Minimum condensing temperature
R-454C	-30 °C	-15 °C	DBT	10 °C	5 °C	NA	55%	15 °C
CO_2 without adiabatic cooling	-30 °C	-15 °C	DBT	10 °C	5 °C	5 °C	55%	15 °C
CO_2 with adiabatic cooling	-30 °C	-15 °C	DBT – 70% × (DBT-WBT)	10 °C	5 °C	5 °C	55%	15 °C

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Table A-2 summarizes the operating parameters of the cooler with a dedicated condensing unit located outdoors

Table A-2

Refrigerant	**Mean Evaporating temperature**	**Suction temperature**	**Condenser air entering temperature**	**Mean condensing temperature difference (subcritical)**	**Subcooling (subcritical)**	**Gas cooler approach temperature (transcritical)**	**Isentropic Efficiency**	**Minimum condensing temperature**
R-454C	-5 °C	5 °C	DBT	10 °C	5 °C	NA	65%	15 °C
CO_2 without adiabatic cooling	-5 °C	5 °C	DBT	10 °C	5 °C	5 °C	65%	15 °C
CO_2 with adiabatic cooling	-5 °C	5 °C	DBT – 70% × (DBT-WBT)	10 °C	5 °C	5 °C	65%	15 °C

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Table A-3 summarizes the modeled AWEF comparison for the cooler and freezer cases. The values are indexed to the R-454C baseline, which is shown as 100 percent for both applications.

Table A-3

Refrigerant and configuration	Cooler, medium temperature	Freezer, low temperature
R-454C baseline	100%	100%
CO_2 with adiabatic cooling	81%	83%
CO_2 without adiabatic cooling	71%	72%

Table A-4 summarizes the modeled additional annual electricity consumption for CO_2 relative to the R-454C baseline. The difference between the with-adiabatic and without-adiabatic cases represents the modeled energy penalty associated with removing adiabatic cooling from the CO_2 configuration.

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Table A-4

Refrigerant and configuration	Cooler, medium temperature	Freezer, low temperature
CO_2 with adiabatic cooling	26,915 kWh/year	45,706 kWh/year
CO_2 without adiabatic cooling	46,775 kWh/year	68,340 kWh/year
Incremental electricity from removing adia-batic cooling	19,860 kWh/year	22,634 kWh/year
Approximate increase from removing adia-batic cooling	74%	50%