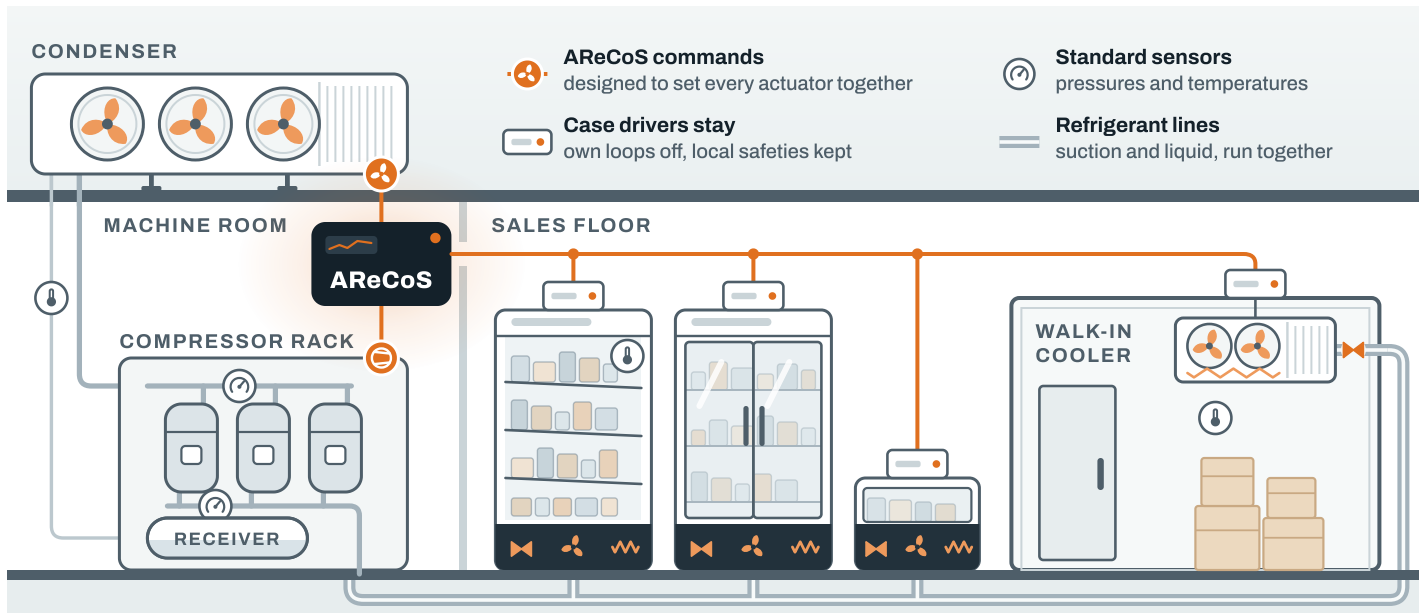


FOR COMPRESSOR RACKS, CONDENSING UNITS AND WALK-INS · HFC AND HFO

One controller for the whole circuit. Every actuator, one decision.

Designed to replace the rack and case loops with one decision: every actuator set together for the least total power that holds the duty.

 U.S. Patent 12,768,557 granted Oct. 20, 2026	 Hardware test published US 2024/0295337 A1, FIGS. 4–7	 Physics model of your machine, on the machine	 No cloud in the control path it keeps deciding offline
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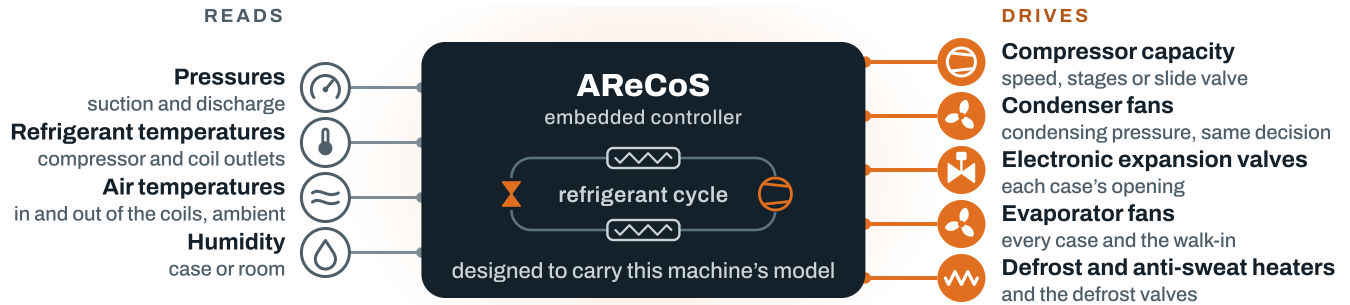


 1 Reads the sensors Pressures, temperatures and humidity from standard sensors.	 2 Models the machine A first-principles model of the machine, for conditions no sensor reports.	 3 One decision Superheat, pressures and capacity together, for the least total power.	 4 Sets every actuator Compressors, fans, valves and defrost, startup to shutdown.
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Sell a machine designed to optimize itself.

 Ship the optimizer inside No integrator, no add-on cloud optimizer: the savings are credited to your machine, and the customer stays yours.	 Commission from a model Set up from a model of your machine. Design goal: no loop-by-loop field tuning.	 Send service to the cause The same model hands your service network the likely cause (page 3).
 If it stops , outputs are designed to go to fail-safe positions set for your machine. Cut-outs, relief and motor protection stay outside its path.	 Alone or under a building system : designed to take setpoints and schedules over BACnet. It owns the actuators, not the goals.	

What it reads, what it drives, and what stays.



Designed to report up: present power, power without a request, and fault flags with the likely cause.

Keep the case drivers on a rack

Takes the rack controller's place. Case valve drivers and controllers carry out its commands; local safeties kept. A case with a thermostatic valve stays outside the decision.

Run a walk-in or unit outright

Drives every actuator itself, one controller per circuit.

Run every phase as one

Startup, running, shutdown and defrost as one problem, with few compressor starts.

Where it sits, and what it works with

No cloud in the control path. It keeps deciding with the connection gone.

Machines share the load over the local network or BACnet.

The grid can ask; the controller decides how, within temperature limits.

Standard parts, many makers. No proprietary sensor or actuator.

✓ Designed to

UL 60730-1 · UL 508A panels · FCC Part 15 B · BACnet (ASHRAE 135) · IEC 62443 practice · EU Cyber Resilience Act. Field-built systems to ASHRAE 15; ammonia plants to IIAR 2.

The record

U.S.
12,768,557

Granted Oct. 20, 2026. Refrigeration plants and natural refrigerants are within the design scope, still to be validated.

Compressor, valve, fans

On a test bench it ran a vapor-compression system in cooling from temperature sensors only.¹

Same core controller

Being built into the AReCoS rooftop and residential heat pumps, and verified against each machine's full physics model.

If it stops: every output to a set position

Case valves

Each driver to the setting chosen for it: its own superheat control or a fixed opening.

Rack pressures

Back to the rack controller kept beneath it, or to mechanical pressure switches.

CO2 and industrial

CO2 high-side valves: backup power or a set position. A package panel: its own control.

¹ US 2024/0295337 A1, FIGS. 4–7.

The cause and where to look, before the truck rolls.

✓ **Rack B** · example message, for illustration

🔌 **Act now: case 14 evaporator fan stopped**

Discharge air up 4 °F since 5:25 a.m. **Product at risk by 9 a.m.** Bring a fan motor; check its breaker first.

❄️ **This week: refrigerant charge falling**

About 35 lb below three weeks ago, falling 12 lb a week. Leak search: the cases and the machine room.

🌊 **Next visit: condenser fouling**

Heat transfer 9% below clean: about 3% more compressor power, some 40 kWh a day.

🔌 **One reading off**

its neighbors agree: the sensor.

🌀 **Several moving together**

the machine.

🔄 **The way they move**

the part. Gas detectors stay.

➡ **Three flows, one answer.** Compressor, valve and heat balance each give the flow; the one that disagrees names the part.

❄️ **Cases and defrost.** A stopped fan told from an icing coil or an open door.

👤 **Charge, counted:** pounds gone, pounds a week, since when. With no level measured and reserve liquid in the receiver, it says the charge cannot be judged yet.

✓ **Ranked by what waiting costs:** now, this week, next visit, or watch. Safety first.

Why leaks matter now

≈¹/₄

of its charge leaked a year by the average US supermarket³

85%

cut in US supply of HFCs by 2036 (AIM Act⁴)

20%

a year: the HFC leak rate that requires repair⁵

📄 **The leak rule.** HFC systems of 1,500 lb or more installed since 2017 need automatic leak detection, alerting at 50 lb or 10 percent lost. With a receiver level transmitter, charge tracking is designed to raise that alert (not yet tested).

³ US EPA estimate. ⁴ AIM Act HFC phasedown. ⁵ EPA leak rule: HFC systems of 15 lb or more, commercial refrigeration.

The grid can ask. The controller is designed to decide how.

A demand-response request is designed to be one more limit on the same decision over every actuator: the least total power, inside the site's product and equipment limits.

A request, not a command

Answered inside limits set at the machine, which no request can change.

Where each kW comes from

Electric defrosts wait first, then compressor speed comes down, fans and pumps rebalanced together.

Shift and recover

Pre-cool ahead of a peak, coast through it, and pace the recovery so the rebound sets no new peak.

 **A baseline from the model:** the power it would have drawn, reported beside what it drew.

 **The link:** OpenADR 2.0b over wired Ethernet as BACnet points. No radio, no cloud command.

Next, together: CO2 and ammonia

 **Transcritical CO2: efficiency.** At 35 °C outdoors, ten bar below the best gas-cooler pressure costs about 26% of the cooling per unit of power; ten bar above, under 4%.⁶

 **Two-stage ammonia: reliability.** In an AReCoS model of a -30 °C plant, the coolest interstage split takes 11.6 °C off the hottest point for a sixth of a percent of efficiency.⁷

Within the design scope; neither has run yet.



The first step: an evaluation on your machine. AReCoS fits a model of your machine, checks it against your own test data and supplies the controller, licensed per unit. Channels, field bus, points list and fail-safe positions are defined with you.

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^{6,7} AReCoS refrigerant cycle tools. CO2: evaporating 2 °C, gas cooler 2 °C above outdoor air, flash tank 45 bar. Ammonia: 40 °C condenser, open flash intercooler. · U.S. Patent 12,768,557 · October 2026 · arecos.net · info@arecos.net