

# Energy Recovery's PX Technology Has Potential; More Data Needed

Companies: BIT.CRL, CARR, DOV, EMR, ERII, HON, KUBT,Y MIELY, PCRFY, VIE

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## Research Question:

**Are Energy Recovery's new product initiatives in CO2 refrigeration and wastewater treatment realistic growth drivers?**

## Summary of Findings

- [Energy Recovery Inc.'s](#) (ERII) new applications for its [pressure exchange \(PX\) technology](#) devices in CO2 refrigeration and wastewater treatment are considered scientifically legitimate and are generating optimism that they will deliver meaningful energy savings.
- Despite the optimism, sources including supermarket chains, OEMs, installers, and specialists in these industries said that currently, too little data is available to speculate on the efficacy or potential level of adoption by potential CO2 refrigeration or wastewater customers.
- If independent testing and OEM endorsements and partnerships emerge to prove PX's effectiveness and demonstrate a positive ROI, the potential for widespread use is significant. Energy Recovery's estimated total addressable market (TAM) of \$1 billion for each market is considered aggressive but reasonable. Sources in Europe cautioned that competitive energy-recovery devices—specifically [ejector technology](#)—are already standard components in CO2 refrigeration systems and will provide formidable competition.
- Energy Recovery, best known as a designer and manufacturer of solutions for seawater reverse-osmosis (SWRO) desalination, developed the refrigeration device at the [urging](#) of the Oak Ridge National Laboratory, which had researched the use of PX technology to improve the efficiency of CO2 refrigeration systems.
- Market conditions in the CO2 industry are favorable for Energy Recovery, as the [AIM Act](#) (American Innovation and Manufacturing) in the United States and [Kigali Amendment](#)—adopted by 130-plus countries to gradually reduce the consumption and production of hydrofluorocarbons (HFCs)—are expected to drive adoption of CO2 refrigeration, which requires higher use of energy in warm environments. In the wastewater industry, regulations are not as strict, and potential customers are likely to be conservative.
- In the CO2 refrigeration industry, Energy Recovery must navigate many well-established OEMs, competitors, and component manufacturers. Nineteen companies were discussed as potential partners and/or competitors. Public companies mentioned include [Hillphoenix](#) and [Advansor](#), both [Dover Corp.](#) (DOV) companies; [Panasonic Holdings Corp.](#) (PCRFY); [Carrier Global Corp.](#) (CARR); [Emerson Electric Co.](#) (EMR); [Honeywell International Inc.](#) (HON); and [Carel Industries SpA](#) (BIT.CRL).
- In wastewater treatment, [Veolia Environnement S.A.](#) (VIE), [Mitsubishi Electric Corp.](#) (MIELY), and [Kubota Corp.](#) (KUBTY) were mentioned.

## Key Quotes

“The technology itself is quite simple. It's been installed in 28,000 [SWRO] facilities around the world. The catch is to scale it down to the size of a supermarket refrigeration system. That should not be a big challenge.”

“The head of our engineering team is enthusiastic about this technical innovation, which he calls the holy grail. Once the module has started, a perpetual flow of energy is created, thanks to the pressure fluctuations, thus decreasing the charge on the compressors—which leads to an optimization, meaning a decrease, in the consumption of energy.”

“The science behind the pressure exchange technology for CO2 refrigeration has potential to improve energy efficiency. It is legitimate. There is not enough information about that specific device by Energy Recovery, PX G1300. I've never seen it installed anywhere.”

“One of the greatest obstacles for Energy Recovery to enter the market is that there are already very strong players and great technologies. It will take a lot of marketing efforts and really impressive showcases and field trials for the company to attract potential partners.”

“They [Energy Recovery] may end up becoming part of the solution, but it seems [at a glance] like their projections are maybe a little overblown.”

	PX Technology	Energy Recovery Growth	Market Conditions
Potential Energy Recovery Customers	Legitimate tech, but unproven in CO2 refrigeration.	If PX proves successful, significant growth is possible.	Favorable regulatory and high energy-cost environment.
Potential Original Equipment Manufacturers and Installers	Legitimate tech, but unproven in CO2 refrigeration.	If PX proves successful, significant growth is possible.	Favorable regulatory and high energy-cost environment.
Industry Specialists	Legitimate tech, but unproven in CO2 refrigeration and wastewater treatment.	If PX proves successful, significant growth is possible.	Favorable regulatory and high energy-cost environment.

## Background

Blueshift Research's initial reporting found Energy Recovery's pressure exchange (PX) technology at the core of many of its products. The technology makes industrial fluid-flow processes more efficient and environmentally sustainable, lowering costs, saving energy, reducing waste, and minimizing emissions. When it was introduced in 2003, PX revolutionized seawater reverse-osmosis (SWRO) desalination. It is now delivering energy savings of up to 60% and efficiencies of up to 98% in SWRO applications around the world. Energy Recovery is now trying to bring its technology to CO2 refrigeration and wastewater treatment to drive future growth.

In the past, Energy Recovery has made promises about mega-SWRO projects and the possibility of success in the oil and gas industry that have not come to fruition. Management is at it again, with a forecast for 25% to 40% annual revenue growth through 2026. The company contends that a more diverse product portfolio will be able to provide solutions for the global water crisis; regulations driving the transition from hydrofluorocarbon (HFC) refrigerants to natural refrigerants such as CO2; and corporate demand for environmental, social, and governance (ESG) solutions.

Energy Recovery is pinning 50% of its future growth on two areas: CO2 refrigeration and wastewater treatment. The company's offering in these industries is just getting started and is based on its core PX technology. Energy Recovery says its PX G1300 is a game-changer for CO2 refrigeration because it reduces energy consumption and operating costs while it increases efficiency. Contracts have been signed with a grocer in Southern Europe, a U.S. grocer, and a rack refrigeration manufacturer. The company estimates that the annual addressable market for PX G1300 will be \$1 billion by 2030.

In industrial wastewater treatment, Energy Recovery projects an addressable market of \$1 billion, with potential to triple that by 2030 if global regulations continue to require water treatment and reuse. The Ultra PX, when used in an ultra-high-pressure reverse osmosis (UHPRO) wastewater treatment system, dramatically reduces the energy needs, costs, and emissions associated with treating industrial wastewater discharge. For the year to date, Energy Recovery reported \$1.6 million in wastewater sales.

Energy Recovery's Q2 performance was mixed, beating Wall Street's earnings expectations but missing revenue forecasts. Revenue declined 1.5% year over year to \$20.3 million, while earnings were reported as a loss of 2 cents per share. The company reaffirmed its full-year revenue guidance of \$130 million, or 25% year-on-year growth. In its industrial wastewater business, total revenue has already exceeded 2021 results by 60% and is on target to achieve full-year sales of \$3 million. In CO2 refrigeration, Energy Recovery reported significant progress with new contracts, progress on its installation at a U.S. grocery chain, and discussions with OEMs. It also [announced that it had shut down its VorTeg operations](#) because it has been unable to find a partner in the oil and gas industry to replace Schlumberger NV (SLB).

## Current Research

Blueshift Research assessed whether Energy Recovery's new product initiatives in CO2 refrigeration and wastewater treatment are realistic growth drivers. We employed our pattern mining approach to establish four independent silos,

comprising 13 primary sources and one secondary source focused on the CO2 refrigeration and wastewater treatment industries. Interviews were conducted Aug. 18-Sept. 9.

- 1) Potential Energy Recovery customers (3)
- 2) Potential original-equipment manufacturers and installers (5)
- 3) Industry specialists (5)
- 4) Secondary sources (1)

## Next Steps

Blueshift Research will continue to review Energy Recovery's pilot projects and the launch of its PX technology in the CO2 refrigeration and wastewater treatment industries to determine the traction it can generate over the next six to 18 months. We will also research competitive products and potential headwinds that may derail Energy Recovery's growth estimates.

## Silos

### 1) Potential Energy Recovery Customers

Three potential Energy Recovery customers representing a U.S. supermarket chain, a European grocery chain and a global cold storage and logistics company are optimistic about the PX technology. They all see strong and growing demand for energy-saving devices in CO2 refrigeration. To gain acceptance, these sources said, Energy Recovery will have to produce data and demonstration projects that prove its energy-saving claims and a favorable ROI. One source said Energy Recovery will need to demonstrate that the PX technology can efficiently be scaled down from large SWRO systems with thousands of gallons of throughput to a few hundred pounds of coolant in a refrigeration system. Another source said the PX technology has an engineering gap that must be closed. He suggested this could be achieved through joint ventures and partnering with OEMs and component manufacturers, possibly including Hillphoenix, Advansor, Panasonic, [Bitzer SE](#), [Dorin SpA](#), [Epta SpA](#), and Carrier. If the company succeeds, the potential exists for significant growth, as regulations including the Kigali Amendment are driving refrigeration to natural coolants globally. Also, Russia's cutoff of natural gas to Europe and high energy costs are major incentives to pursue the energy savings that the PX technology may offer. One source cautioned that the powerful U.S. chemical lobby was working to discredit the use of CO2 in favor of a new chemical refrigerant.

### Key Silo Findings

#### Background

- 1 source represents a U.S.-based supermarket chain interested in testing the PX technology.
- 1 source is the director of technology for a European grocery chain who was unfamiliar with PX technology, but his engineering team is and referred to it as the "holy grail."
- 1 source represents an international food warehousing company that knows about PX technology but is not using it.

#### Energy Recovery's PX Technology for CO2 Refrigeration

- 3 are optimistic about the potential for PX as an energy-saving device in CO2 refrigeration.
  - o 1 said the technology is simple—borrowing high pressure to increase low pressure—but it must be proved in a real installation.
  - o 1 said his chief engineer says the PX technology is the "holy grail"; still, additional testing and engineering are needed in the CO2 refrigeration industry.
  - o 1 said that if Energy Recovery's PX technology can improve efficiency and can be used as a retrofit product, they will consider it.

#### Energy Recovery's Growth Potential

- 3 said Energy Recovery has significant growth potential, provided it can prove a positive ROI.

#### Market Conditions and Competitive Landscape

- 3 said market conditions are favorable for PX technology, as regulations and high energy costs are driving demand.
- 1 said ejector technology is similar to PX technology and is currently in use in Europe.

## 1) Energy and sustainability director at a supermarket chain

Energy Recovery will have to implement its PX technology in a real supermarket setting and evaluate the results of its pilot test before anyone can say its product is successful. If the device, which has been used in huge desalination projects, can in fact be scaled down to a much smaller supermarket, it will be a huge breakthrough in the market. Regulations against the use of HFCs will go into effect in 2030 in California, driving the uptake of CO2 refrigeration systems. CO2 uses more energy in hotter climates, but using Energy Recovery's technology eliminates arguments against CO2 not being efficient enough. The technology makes sense, based on its successful use in desalination facilities, but it remains to be seen whether scaling it will also yield good results.

### Background

- Grocery chain. Source is the energy executive.

### Energy Recovery's PX Technology for CO2 Refrigeration

- "The technology itself is quite simple. It's been installed in 28,000 [SWRO] facilities around the world."
- "The catch is to scale it down to the size of a supermarket refrigeration system. That should not be a big challenge."
- "The [PX] technology device was designed for super-high-pressure desalination projects—huge systems with thousands of gallons. Now it has to be scaled to a supermarket with a few hundred pounds of CO2. In principle, it should not be a problem to scale it up or scale it down. But there could be a problem that has not yet been encountered."
- "Before I can say it will definitely work, I would like to see it implemented [and see the results]."
- "The technology makes sense. In a typical refrigeration system, there are compressors compressing the refrigerant or gas into very high pressure. That is then released into the water condenser, completely losing all the energy that was spent pressuring the refrigerant. The device takes a stream of the high-pressure refrigerant and mixes it into the low-pressure refrigerant. Basically, they are borrowing some of the high pressure to increase the low pressure. As a result, the amount of energy you need to input to increase the pressure of the refrigerant is reduced drastically."
- "The process doesn't indicate any conflict with any of the principles of the conservation of energy."
- "I can't think of any roadblocks. I feel very positive about the technology."

**"The technology itself is quite simple. It's been installed in 28,000 [SWRO] facilities around the world. The catch is to scale it down to the size of a supermarket refrigeration system. That should not be a big challenge."**

Energy and sustainability director  
at a supermarket chain

### Energy Recovery's Growth Potential

- "This would be a huge breakthrough in the market."
- "In California, there is a regulation that by 2030, you will not be able to use any refrigerant other than CO2. CO2 has a GWP (global warming potential) of 1, and the California Air Resource Board wants to reduce the greenhouse-gas potential to less than 150. There are no other refrigerants out there that can meet that goal except for CO2."
- "CO2 tends to use more energy in hot weather. By employing this technology, all the arguments against CO2 go away. The potential is huge. Refrigeration uses a lot of energy."

### Market Conditions and Competitive Landscape

- "I'm not aware of any competitors to the Energy Recovery device."

## 2) Technical director for a supermarket chain in Western Europe

Energy Recovery's PX technology could save energy costs in CO2 refrigeration and is similar to the ejector technology used in Europe. It is used in warmer climates in Southern Europe, most commonly in Spain, Portugal, and Greece. Many supermarkets in Europe still need to be converted from chemical refrigerants, as they are being phased down because of the Kigali Amendment. CO2 refrigeration makes the most sense because of its sustainability and energy savings. Energy Recovery's PX device in warmer climates would mean more energy savings at a time when Europe is being cut off from Russian gas, and energy costs are sky rocketing. Depending on the ROI they can prove, it would make good business sense there. Energy Recovery will have to partner with OEMs such as Hillphoenix and Advansor and component manufacturers such as Bitzer to penetrate markets and find end users. In Japan, they could partner with companies such as Panasonic that are installing smaller systems in convenience and proximity stores. The U.S. market will be more difficult to penetrate, in part because of the powerful chemical lobby—including companies such as Dupont. These

companies are trying to discredit the use of CO2 in refrigeration systems and are instead developing a new chemical refrigerant that will not be harmful in terms of greenhouse gasses but is said to cause acid rain. Also, because U.S. energy costs are not as high as in Europe, the urgency to find energy savings is less.

## Background

- Energy director of a supermarket chain in western Europe.
- Had not heard of Energy Recovery until this conversation.
- Track record of installing CO2 refrigeration in their supermarkets.
- Source is unfamiliar with this product but reviewed with the engineering team.

## Energy Recovery's PX Technology for CO2 Refrigeration

- "The head of our engineering team is enthusiastic about this technical innovation, which he calls the holy grail. Once the module has started, a perpetual flow of energy is created, thanks to the pressure fluctuations, thus decreasing the charge on the compressors—which leads to an optimization, meaning a decrease, in the consumption of energy."
- "On the other hand, although positive results were obtained with desalination installations, there will be more engineering needed to determine how and where in a CO2 refrigeration installation this module can be built in."
- "I would consider—and we are actually considering—using this technology. Cost, savings, and ROI are important elements, and they would impact my decision. We are seeing that the prices [that we know about today] are rather high and seem to be calculated in function of an ROI of six years, rather than the actual manufacturing cost."
- "The Energy Recovery technology looks to me like it's a known technology."
- "In Europe, this is known as the ejector technology."
- "It's something that's used in warmer climates, in Southern Europe—very commonly in Spain, Portugal, and Greece—for CO2 installations."
- "It's a proven technology. It's a good solution for a warmer climate."

"The head of our engineering team is enthusiastic about this technical innovation, which he calls the holy grail. Once the module has started, a perpetual flow of energy is created, thanks to the pressure fluctuations, thus decreasing the charge on the compressors—which leads to an optimization, meaning a decrease, in the consumption of energy."

Technical director for a supermarket chain in Western Europe

## Energy Recovery's Growth Potential

- "For this product to be successful on the market, there is an engineering gap that needs to be closed. This can be done in different ways—by Energy Recovery or by cooling-rack manufacturers, or in a joint venture."

## Market Conditions and Competitive Landscape

- "There is still a ways to go in terms of how many supermarkets have to phase out their greenhouse gasses. If they're still using them, it becomes more and more expensive to refill their installation after a leak. The quota of the Kigali Amendment serves as a stick to move everybody forward toward a more sustainable solution."
- "In Europe, it makes business sense to move in that direction. Sustainability does not need to be the main objective. Energy savings is also an important factor. When we install an integrated CO2 solution in an existing building, there is an energy consumption decrease of about 20%. In a new building, where there are new building standards and top-notch insulation and no leakage, you have a decrease of 40% in energy consumption."
- "U.S. supermarket operating companies are more hesitant to switch to CO2 refrigeration than in Europe. [We have a track record of implementing CO2 refrigeration in our supermarkets for over 15 years.] Lower energy costs in the U.S. mean less pressure to find more energy-efficient systems."
- "When the U.S. phases down HFC refrigerants in 2036, supermarkets will have to go to something else, whether it's CO2 or ammonia or propane or another gas."
- "The refrigerants we have now are harmful for the climate, so we have to get away from them. At the same time, companies like Dupont are developing refrigerants which they say have no greenhouse effect and are just as harmless as CO2. The large chemical companies are always looking for solutions for refrigerants that don't have a greenhouse effect. [But this new chemical refrigerant would cause acid rain](#). Sometimes the solution for something creates another problem. They would be replacing HFCs with another gas that will have to be phased out in 20 years."
- "There is a lot of lobbying by competitors worldwide to put natural refrigerants in a bad light. Dupont is one of the major chemical companies. The chemicals became popular in the 1930s because it was easy to produce them, and you didn't have to have the high-pressure installations. Today, we can build those installations, and we can

guarantee the quality of the piping. It's much better than what it was in the past. It's a revival of the technology that already existed but was pushed out of the market."

- "The chemical refrigerants made our life easy for a while, like plastics also did [until we learned about the harm they cause]."
- "Parallel compression is one of the most commonly used technologies in Europe. It's an integrated solution. You don't bring in the cold; you just take out the heat. In a supermarket system, we have heat that we extract from the cooling cabinets, and then we use the reclaimed heat to heat the supermarket and also to cool it and also to provide hot water."
- "In a dense urban area where square meters are expensive, this allows you to limit the surface for technical spaces, and you can keep more of your surface for commercial activities."
- "This makes sense in Europe but less in the U.S., where space is at less of a premium."
- "One of the companies that operate in Europe and also in the U.S. are Hillphoenix, which acquired a Scandinavian company called Advansor. They build compressor racks. It's the heart of the installation. This would be the part that goes in a technical room. Other companies build cooling cabinets. Some of the well-known ones produce globally, like Epta. There are also companies like Carrier that build turnkey solutions—the rack and the cooling cabinet. These kind of companies can offer a full turnkey package."
- "Japan is also advanced in this area, but there it's more medium-sized supermarkets. Their racks are smaller—from manufacturers such as Panasonic—so it's possible for a new company to test with them as well. The market was first focused on large-sized supermarkets, but now it's smaller convenience and proximity stores. They are finding technical solutions for those. The market is reorienting."
- "As you look at possible markets, you have to take into account the component manufacturers. For example, compressor manufacturers would want to make sure that it is their compressors that are being used."
- "Companies that build this kind of technology in Europe approach builders like Advansor or Hillphoenix to use their ejectors in their racks. Component manufacturers can approach end users like us, for example, to use certain compressors like Bitzer or Dorin into the racks that they are installing. They are trying to change the market by going to the end user and convincing the end user that they should write in their technical specs that a specific brand should be used for their racks."
- "CO2 refrigeration installations can be upgraded with an ejector. It's a kind of extra that you can add on. [Theoretically, the PX device could be added]."
- "Everybody is looking to have more efficient systems."
- "Energy efficiency is very important at the moment, with energy prices going through the roof because Russia has been cutting European countries off from Russian gas."
- "We are in a moderate climate area, but with the effects of climate change, we are already experiencing much hotter summers and more heat waves."
- "This technology can make business sense because it will save on energy costs, which are increasing so much currently, and you will gain in sustainability. It's a proven technology, so the question is if they [Energy Recovery] can make their place in the market."
- "California is at the forefront of advancing sustainability in the U.S. It's a question of how fast they can go."

#### Miscellaneous

- "Many people are shocked that we want to put the CO2 we want to prevent from going into the atmosphere in a refrigeration installation. But the CO2 that goes in refrigeration is a byproduct of industrial processes. You have to capture it and then use it in fluorinated gasses. If 1 kilogram escapes, it's the equivalent of 4 tons of CO2. If 1 kilogram of CO2 escapes, it remains 1 kilogram. Factor that in an installation that has 300 kilograms of refrigerants. Some people say that as long as the refrigerant stays within the installation, it doesn't matter what you put in it. That is the mindset of some supermarket operators in the U.S. Retailers have installations that can be 20 or 25 years old."

### 3) Vice president of an international food warehousing company

This source, a vice president of an international food warehousing company, sees great potential for any new energy-saving technologies. Because many retailers are changing their refrigeration systems from HFC to natural refrigerants, the demand for solutions improving energy efficiency is strong and growing. If Energy Recovery can prove that its products deliver the expected energy savings, then it can achieve its projected sales that the company articulated earlier.

So far, with all the innovations, the source was able to achieve an 18% decrease in energy use, and that was a tremendous success. CO2 refrigeration is not the only solution existing in the market, and ammonia seems a safer option while being almost as efficient as CO2. Retrofitting is always a preferred option. If, upon trials and field tests, Energy Recovery products can be retrofitted to the existing systems, that would mean much better opportunities for the company to gain market share. Despite the competition, the energy market favors innovative products.

## Background

- Source represents a global provider of temperature-controlled supply chain and logistics solutions.
- They are storing, handling, and transporting food products, mostly frozen or chilled, around the globe. The company operates 400-plus temperature-controlled facilities.
- The company is aware of PX technology but didn't consider it for its refrigeration system.

## Energy Recovery's PX Technology for CO2 Refrigeration

- "We are constantly researching all possible options for more efficient refrigeration. CO2 is in the list of natural refrigerants that we are considering for our facilities. So far, we are inclined toward ammonia field-constructed solutions. We are open to any options, but this solution proved to be more efficient and safe. We put safety first."
- "We rely on our engineering partners in different countries, including [CrossnoKaye](#) [Inc.], who designed a cloud-based climate control system for us. If they say that Energy Recovery can help us to improve our efficiency, we'll consider their offer."
- "We are not new to retrofitting, and when possible, we retrofit. We have a mix of technologies in our facilities now, because we acquired them from different companies. Retrofitting is the first choice for us because it is almost always the most reasonable and clean solution. If PX G1300 is something that can be added to our system worldwide and improve its efficiency by 20% to 25%, it would be great."
- "As for market potential, I don't think there are any obstacles for innovations that promise energy saving and energy efficiency. Of course, any new player should first provide proof that those innovations can be implemented safely and would really deliver those promises."
- "We achieved [an] 18% decrease in energy usage, and that means tremendous savings. We readily test any reasonable ideas. If they prove to be working, they become a part of our global installations."

## Energy Recovery's Growth Potential

- "[The] total available market can be even bigger [than \$1 billion], and the opportunities are endless if the technology proves its efficiency."  
"We are replacing HFC with natural refrigerants; this is our highest priority now. There are many other companies doing the same across the world and in the U.S. because of the new regulations. If Energy Recovery publishes any convincing trials, they can make the projected sales, why not? The market is big."
- "Saying all that, trials go first. As much as we like playing with new ideas, they should be well-grounded in research and field data."

"[The] total available market can be even bigger [than \$1 billion], and the opportunities are endless if the technology proves its efficiency."

Vice president of an international food warehousing company

## Market Conditions and Competitive Landscape

- "The market is favorable for new energy-saving solutions. And though there are existing technologies, and competition is tight, when it comes to technologies, a breakthrough solution is a winner."

## 2) Potential Original-Equipment Manufacturers and Installers

Five professionals in refrigeration manufacturing said the PX technology is legitimate but unproven in the CO2 refrigeration industry. All agreed that additional data and verification of positive results is needed for the technology to prove its efficacy and gain acceptance. One source who is in partnering meetings with Energy Recovery said the company will have to demonstrate that the PX technology can be scaled down to smaller stores—which are the norm in Europe, where this source is located. He said they need to be sure that controls are compatible and that PX is competitive with current manufacturers' systems and ejector technology, which is well-established. If the additional data is positive, a product like the PX G1300 has significant potential and will be widely adopted. Partnerships with OEMs, refrigeration component manufacturers and engineering firms are universally seen as the way to move PX forward. Demand for products such as Energy Recovery's PX G1300 is growing as the regulatory environment is mandating natural refrigerants and energy costs are rising. Energy Recovery's total addressable market for its product—\$1 billion—is considered large but not unreasonable. Competition is considered significant, but one source said they are unaware of any company that has a similar energy-saving product. Competitors discussed by one source include [Danfoss](#), [Carel](#), [Wurm](#), and [Honeywell](#). One OEM contacted by Blueshift Research declined our interview, citing a nondisclosure agreement with Energy Recovery. They did share that they would not be participating in any pilot projects with the company.

### Key Silo Findings

#### Background

- 5 executives in the refrigeration industry.
  - o 1 said they were in a meeting to possibly become an Energy Recovery partner.
  - o 1 source declined our interview, citing an NDA with Energy Recovery. They did share that they would not be participating in a pilot project.

#### Energy Recovery's PX Technology for CO2 Refrigeration

- 5 said the PX technology is real but unproven in the CO2 refrigeration industry. Successful pilot projects, independent verification, and partnering endorsements from OEMs and engineering firms will be needed to advance its use and adoption.

#### Energy Recovery's Growth Potential

- 5 said that if the PX technology is successful in pilot projects, the growth potential is significant.
- Energy Recovery's projected TAM of \$1 billion is considered large but not unreasonable.

#### Market Conditions and Competitive Landscape

- Market conditions are favorable, with regulations driving growth in the CO2 refrigeration industry and high energy costs driving demand for cost-saving solutions.
- Competition in the industry is plentiful and comes from primarily the proven ejector technology.
- Companies discussed as competition included Danfoss, Carel, Wurm, and Honeywell.

## 1) Refrigeration technical director for a national industrial construction company

This refrigeration technical director for a national engineering company sees PX technology as being plausible and reasonable but was unable to comment on the specific parameters of the product because so far, information is insufficient, and successful installations are few. In light of upcoming regulations and growing energy costs, demand for solutions that potentially improve energy efficiency is growing rapidly, and the potential for PX G1300 can be big. The company needs to prove that this solution delivers the promised increase in efficiency. To do that, it probably would have to establish partnerships with major equipment manufacturers and engineering companies. Retrofitting shouldn't create many problems, so even if it'll take time for Energy Recovery to collect the actual use data and proof, it should be able to work with existing installations.

#### Background

- This source represents a national building systems design firm with an array of engineering services and a portfolio representing a full range of markets including business, community, retail, healthcare, and venue. One of the services the company has provided for years is grocery/refrigerated warehouse/cold storage and retail design, with the focus on cost-effective, energy-efficient, and environmentally friendly solutions.



- The company has experience in CO2 refrigeration installations but hasn't used Energy Recovery products yet. The source has heard about the PX technology but doesn't use any of the available products yet.

## Energy Recovery's PX Technology for CO2 Refrigeration

- "The science behind the pressure exchange technology for CO2 refrigeration has potential to improve energy efficiency. It is legitimate."
- "There is not enough information about that specific device by Energy Recovery, PX G1300. I've never seen it installed anywhere."
- "There are quite a few competing solutions in the market doing what Energy Recovery's PX G1300 does and not enough working installations to make any decisions on any of them."
- "The product may be just fine; it is just a very early stage of adopting the technology. It is an early stage for CO2 refrigeration in the U.S. in general."
- "If the company works closely with the major manufacturers and engineering companies, and the product is as good as they say, then there is a potential for a rapid growth. The market is growing very fast."
- "From the point of engineering, I don't see what predicaments could deter the company to grow in the fast-developing market. It's more about marketing, communication, and partnerships with manufacturers."
- "Each installation is different, and it takes different approaches and solutions. There is room for Energy Recovery, as energy efficiency is every customer's major concern these days. But only time and experience will show whether their products deliver their promises."

"The science behind the pressure exchange technology for CO2 refrigeration has potential to improve energy efficiency. It is legitimate. There is not enough information about that specific device by Energy Recovery, PX G1300. I've never seen it installed anywhere."

Refrigeration technical director for a national industrial construction company

## Energy Recovery's Growth Potential

- "I don't know what Energy Recovery put into their calculations to estimate the total available market, but one thing is certain: CO2 is growing very fast globally."
- "If Energy Recovery can show convincing tests and successful cases, they'll take a good share in this market. Again, too soon to say anything before we see it working."

## Market Conditions and Competitive Landscape

- "The market conditions are favorable for new technologies to emerge and grow."
- "Not just the regulatory pressure to switch to CO2 may drive the demand for technologies like PX G1300, but also the need to improve energy efficiency. Energy rates are growing, and most likely, they will keep growing. For grocers, food warehouses, and such, investment in the improvements in energy efficiency is no longer a fancy trend—it is a necessity."

## 2) Vice president of an industrial HVAC and refrigeration company

This vice president of a North American company that designs and installs HVAC and refrigeration systems for food retailers, cold warehouses, and condominiums acknowledges a great potential for CO2 refrigeration and foresees explosive growth in demand for any technologies that contribute to energy efficiency and help reduce the carbon footprint. Yet he says the competition between technologies that already have proved their efficiency is tight, and it will take a lot of effort for a new technology to take a considerable market share. Energy Recovery hasn't published field trial results yet, and evidence is unpersuasive that its solutions are economically feasible or at least work in real-life installations. Until then, it is unlikely that big players in the market will pay any attention to PX G1300.

### Background

- The company has over 60 years of experience in engineering and manufacturing refrigeration systems and HVAC for grocery retailers, cold warehouses, and condominiums. The company provides energy management services and promotes comprehensive solutions that aim to reduce energy waste and greenhouse-gas emissions. The company serves customers all across Canada and the U.S.
- The company designed and installed a few CO2 refrigeration systems in Canada, using a number of approaches and combining HVAC and refrigeration systems with its own heat-change technology. It hasn't used or considered Energy Recovery products yet, prioritizing its own technologies and various combinations of engineering solutions.

## Energy Recovery's PX Technology for CO2 Refrigeration

- “There is a difference between science that backs this or that technology and specific implementations of it. The science behind the pressure exchange technology is real. That doesn’t mean that the devices based on that technology will work as they are supposed to. This is a long road of tests and trials.”
- “There are other technologies and solutions that already proved their efficiency. We designed and built a refrigeration system for premium grocery stores where we used our compressor rack system based on [R448A](#), a high-performing synthetic refrigerant that has a very low global warming potential. CO2 is not necessarily the optimal solution for everyone. For another grocery retailer, we created a system that unites refrigeration, water heating, and HVAC. So we reduced energy waste there to zero. Excellent, totally reliable technologies already exist, and they proved to be working and saving our customers a lot of money.”
- “I tend to not trust the solutions that are advertised as ‘one size fits all.’ When we work on a project, we tailor our systems for each customer and often for each specific store. We design comprehensive solutions, which means that we take a project as a whole—because each building functions as a whole system in particular conditions, such as climate, usage patterns, and such. This is so much more than just one pump.”
- “One of the greatest obstacles for Energy Recovery to enter the market is that there are already very strong players and great technologies. It will take a lot of marketing efforts and really impressive showcases and field trials for the company to attract potential partners.”

“One of the greatest obstacles for Energy Recovery to enter the market is that there are already very strong players and great technologies. It will take a lot of marketing efforts and really impressive showcases and field trials for the company to attract potential partners.”

Vice president of an industrial HVAC and refrigeration company

#### Energy Recovery’s Growth Potential

- “The estimation of the total available market is not unreasonable. The question is what share Energy Recovery is able to take. The competition is already very tough.”
- “I expect explosive growth in demand for any technologies that result in energy saving. Regulatory pressure is also increasing, so many retailers are ready to make investments in technologies that are greener, safer, and more efficient.”
- “This is a time-sensitive matter. The sooner Energy Recovery can showcase anything, the better, because after investing in new climate and refrigeration systems ... and reducing energy usage,... not many retailers would be ready to commit another lump sum to improve the system that works perfectly well without it. Maybe retrofitting would work, but who would need it?”

#### Market Conditions and Competitive Landscape

- “It is true that energy efficiency is a very hot market, and it is getting even hotter. But the competition between technologies and manufacturers is very high.”
- “At this moment, we can only speculate about PX G1300. Any meaningful discussion will be only possible after there have been trials and real-life cases.”

### 3) [Nasser Karimzadeh](#), chief industrial refrigeration engineer at VaCom, a subsidiary of Bitzer U.S.

Energy Recovery’s new product initiative in CO2 refrigeration looks interesting and can work. It can be a growth driver for the company as supermarkets continue to convert to CO2 refrigeration. With increasing signs of climate change this year, pressure will increase to stop using synthetic refrigerants and switch to CO2 because CO2 is the only safe natural refrigerant for supermarkets. Its growth will also be a function of how energy costs change. Energy Recovery’s projected TAM and revenue projections for 2026 are reasonable. The company would stand to gain by working with component manufacturers that could use their product in the CO2 refrigeration packages they sell.

#### Background

- Product development for a component manufacturer
- Looked up product to learn about it

#### Energy Recovery’s PX Technology for CO2 Refrigeration

- “The technology is interesting. I think it can work.”
- “It seems like unique technology. There are a lot of technologies that save energy [in CO2 refrigeration], but I have not seen anything similar to this.”

## Energy Recovery's Growth Potential

- "There is a big market potential for this kind of product. Without knowing the unit cost for this device, it's hard to say more."
- "If they go to market, they could maybe sell 20 units the first year, then 100 units in the second year. Of course, that's a guess."
- "Their TAM of \$1 billion by 2026 is not unsurprising."
- "I'd like to say yes, that projected sales of \$100 [million] to \$150 million in this space by 2026 are attainable. However, it will also be a function of where energy costs are going to be. But it's feasible."
- "CO2 has become the dominant refrigerant for supermarkets in Europe. In the United States, we haven't even scratched the surface of that market yet. There is substantial potential for CO2 refrigeration in the future."
- "Whether U.S. supermarkets convert to CO2 refrigeration will be partially dependent on the direction of government regulations. Based on what I've seen this year with climate change, I feel fairly confident it is going to happen. Sooner or later, the industry has to switch to a natural refrigerant. The industry doesn't have a substitute for natural refrigerants that doesn't have an impact on climate change. There are no satisfactory synthetic refrigerants right now. As it stands, CO2 refrigeration has the deepest chance for supermarkets."
- "There are only three natural refrigerants. Methane is natural, but it's flammable, so it's unlikely it will be used. Ammonia is toxic, and it is in industrial use but cannot be used in the supermarket space because of its toxic nature. That's why transcritical CO2 will be the dominant refrigerant for supermarkets for the future."
- "Without technical information, I don't know how they will be using this technology."
- "I'm not sure who Energy Recovery's target client is. We make CO2 system packages. Energy Recovery would be better off working with other manufacturers. From what I see, the device is not something that they could sell to just anybody. It would be better if they target the manufacturers that make CO2 packages selling to the end user, like us."
- "The technology could work and be a growth driver for Energy Recovery."

"The technology could work and be a growth driver for Energy Recovery."

Nasser Karimzadeh, chief industrial refrigeration engineer at VaCom, a subsidiary of Bitzer U.S.

## Market Conditions and Competitive Landscape

- "It's a crowded market. There could be 10 or 20 competitors active in the space that Energy Recovery is in."

## 4) A vice president of technical sales at a company that serves the refrigeration and HVAC industries

Although Energy Recovery's PX G1300 technology is not widely available for review, as a concept, it seems to be a legitimate product that could have a significant impact in the market. To gain acceptance, the company must partner with CO2 refrigeration system OEMs for independent testing to verify its energy-saving claims. The use of CO2 refrigeration is escalating, and Energy Recovery's estimate of a \$1 billion TAM for its product is aggressive but possible. Energy Recovery's short-term growth in CO2 refrigeration will be challenged by significant industry lead times for CO2 equipment and components. The cost of adding another component to the system will also be a challenge that must be addressed.

## Energy Recovery's PX Technology for CO2 Refrigeration

- "Speaking from a concept standpoint and test results they've provided from their facility, it seems like a legitimate product and something that could have an impact on the market."
- "They need to partner with a few CO2 refrigeration system OEMs and have them do some independent testing in their test labs to validate the data that Energy Recovery has shown. If the OEMs see similar results and see the value, then [they should] get some of the retailers that are leading the way in terms of going with natural refrigerants onboard to do a test site and see how things go in a real-life setting."
- "For people to want to adopt it and include it as part of their design standard and include it in their stores or in their system design, it is going to have to have some sort of favorable ROI."
- "Retailers are focused on upfront costs, and there are regulation changes happening that are pushing folks toward using CO2. But along with that you end up having a cost barrier. Everybody is conscious of how much a standard HFC costs these days. CO2 systems aren't quite [at] parity in terms of cost, so if this is a higher cost and a longer-ROI component, it is going to take longer for them to see meaningful revenue."

- Headwinds and roadblocks: “Cost is going to be one. And then having partners—equipment OEMs, retailers, or commercial light-industrial cold-storage facilities—they are going to need some folks who want to try this and who are willing to share the data so that it gets out there. Once they do that, if it works, and if it works as advertised, I think they could definitely see a big impact on the market.”

## Energy Recovery's Growth Potential

- “Significant growth in the short term for Energy Recovery, It’s going to be tough with CO2 equipment lead times. 2023 stuff is already in the works. Unless they are already doing stuff with OEMs.”
- “A TAM \$1 billion seems to be a stretch. But the market is shifting to using CO2 and natural refrigerant, so there is going to be a pretty good uptick in CO2 refrigeration systems that are sold. So it is quite possible.”

## Unique Features/Competitors

- “At this point, I don’t know of anybody who has a similar product to it.”
- “There are different products and technologies to help with efficiency of CO2 refrigeration systems, but they have been slow to adopt because of added upfront costs and a controls complexity standpoint. But having one main internal moving part might be something that solves some of those challenges.”
- “As far as actual competition, I don’t know if there is one specific to this product. I don’t know of anyone else doing this exact thing.”

“They need to partner with a few CO2 refrigeration system OEMs and have them do some independent testing in their test labs to validate the data that Energy Recovery has shown. If the OEMs see similar results and see the value, then [they should] get some of the retailers that are leading the way in terms of going with natural refrigerants onboard to do a test site and see how things go in a real-life setting.”

A vice president of technical sales at a company that serves the refrigeration and HVAC industries

## 5) Executive with a European CO2 refrigeration design and installation firm

Energy Recovery will have to demonstrate that the pressure exchanger can be scaled down to smaller stores, which are more prevalent in Europe; that there are controls to manage it; and that the PX technology can be competitive with established manufacturers of ejector technology, which already has proved it works in Europe and has widely available controls. Energy Recovery will also have to demonstrate that the CO2 refrigeration systems where it is installed can work with or without its technology. If all these conditions are met, it would take at least two to three years for the pressure exchanger to become more mainstream. Growth is more likely to occur in the U.S., where the PX technology could drive growth in the currently low level of CO2 refrigeration. CO2 has now become standard in many European grocery stores, so the pressure exchanger will have to prove its ability there to increase efficiency and energy performance. An additional segment that could drive growth is CO2 refrigeration in industrial warehouses.

## Background

- Project executive with European industrial and commercial refrigeration company that designs and installs transcritical CO2 systems.
- Has met with company to learn more about the technology and discuss eventual partnership for Europe and will continue meeting with them.

## Energy Recovery's PX Technology for CO2 Refrigeration

- “This is a very young product. We have to understand it better and see if it is suitable for European-sized supermarkets, which are smaller than those in the U.S. There’s a concern that the technology is more suited for medium and larger-sized supermarkets.”
- “My first impression is that this technology is very interesting, but I’m not sure how it fits in with CO2 refrigeration units. They have a lot of experience in water treatment but not yet in CO2 technology.”
- “There are issues regarding the pressure and the needed additional compressors to use the pressure exchanger technology. Their system is interesting, but I’m not 100% comfortable with how it can be used with refrigeration units, which must not only be efficient but 100% available.”
- “Without all the information, I will only have a clearer idea about how suitable it is after our next meeting.”
- “Assuming everything works as they plan, it will take at least two or three years to become more mainstream.”

## Energy Recovery's Growth Potential

- “I don’t really know if their TAM can be that big globally. They would like their pressure exchanger to drive growth in CO2 technology in the U.S. However, in most of Europe, CO2 technology is now standard. The PX device would be used just to increase efficiency and the capacity of the compressor racks but not to make CO2 refrigeration a

potential choice. Customers are already using CO2 refrigeration. The pressure exchanger would be used only to guarantee to the customer that they will have lower energy consumption and better efficiency.”

- “There is also a potential market in large-capacity refrigeration in industrial settings in Europe, such as in industrial warehouses. This could also be suited for the PX technology.”
- “In fact, the pressure exchanger is probably well-suited for such large industrial settings, but they will have to demonstrate if it can be scaled down to smaller-store-sized settings.”
- “Another important factor is availability. A refrigeration system has to be able to work with or without the pressure exchanger. For example, on a compressor rack with the ejector technology, if the ejector has problems, the compressor rack can also work without the ejector. The same conditions would apply for the Energy Recovery pressure exchanger. A compressor rack must be able to work with or without the PX exchanger.”
- “It’s a very complicated system, but this additional complexity must be justified by a comprehensive energy-efficiency offering.”

“Assuming everything works as they plan, it will take at least two or three years to become more mainstream.”

Executive with a European CO2 refrigeration design and installation firm

### Market Conditions and Competitive Landscape

- “If it works, it could definitely be adopted, but there will be a lot of competitors. There is existing technology, such as ejectors, which have a similar goal as the PX device. The ejector technology is now a widely tested solution. There are a lot of manufacturers and a lot of electronic controls that are capable of managing the ejector technology.”
- “I have to first understand how difficult controls might be, the size of the compressor rack, and the economic issues to see if they can be competitive or not with existing technologies.”
- “Some of the companies that manufacture ejector devices are Danfoss, Carel, and Wurm. Danfoss, Carel, and Honeywell are examples of companies that manufacture controls that can manage the ejectors.”

## 3) Industry Specialists

Three industry specialists representing the CO2 refrigeration industry and two specialists from the wastewater treatment industry view Energy Recovery’s PX technology as legitimate, yet unproven. All sources said Energy Recovery will need to run pilot projects, seek third-party validation to prove effectiveness, and prove a meaningful positive ROI for the technology to be adopted. Sources said the company must establish relationships with OEMs and CO2 and wastewater consulting/engineering firms to penetrate the markets, which could take up to 10 years. A source representing a CO2 trade organization said PX is similar to ejector technology, which is widely used in Europe and considered a standard that is built directly into refrigeration systems. Sources considered Energy Recovery’s future revenue projections aggressive but not unreasonable if the technology proves itself. The U.S. is where Energy Recovery has significant opportunity for growth in CO2 refrigeration, as its use is just beginning. One source said 98% of supermarkets in the U.S. are still using HFCs, while in Europe 80% of grocery stores already use CO2. In the wastewater space, one source sees opportunity for Energy Recovery’s PX technology in lithium mining. The other wastewater specialist said the company will be challenged to persuade potential buyers to use PX technology, as it introduces another point of potential system failure, and he questions whether the energy savings is worth it. The CO2 refrigeration market is expected to experience significant growth, as it is being driven by the AIM Act in the U.S. and the Kigali Amendment globally. The wastewater industry regulatory environment is not as strong, so potential customers will be averse to trying new treatment ideas and solutions. Companies discussed as both potential partners for promoting the PX technology and competitors in CO2 refrigeration include [Hussmann Corp.](#), Hillphoenix, [Kysor Warren](#) (Epta S.p.A.), [Zero Zone Inc.](#), [Enex Srl Su](#), Danfoss, Carel, Emerson, and [Baltimore Aircoil Co.](#) In the wastewater market, competitors and potential partners discussed were Veolia Environnement, Mitsubishi, and Kubota.

### Key Silo Findings

#### Background

- 1 source is a former executive in the refrigeration industry.
- 1 source is an executive for a CO2 refrigeration trade association.
- 1 source is a researcher at a national laboratory.
- 1 source is a wastewater treatment expert.
- 1 source is a senior engineer at a wastewater treatment consulting firm.

## Energy Recovery's PX Technology for CO2 Refrigeration

- 3 said Energy Recovery's PX technology is legitimate but unproven.
  - o 1 said the PX technology is unique but will require support from OEMs and consultants to gain acceptance, which could take 10 years.
  - o 1 said the PX technology is similar to ejector technology, which is widely used in Europe. To gain acceptance, third-party validation and a solid ROI will be required, along with relationships with OEMs.
  - o 1 said the PX technology has a promising future but needs to mature.

## Energy Recovery's PX Technology for Wastewater Treatment

- 1 said the technology is legitimate but needs a pilot project to demonstrate potential energy savings. Partnering with wastewater engineers will also be needed.
- 1 said the PX technology should work, but convincing potential buyers will be a challenge. He questions whether the cost of the technology is worth the potential savings.

## Energy Recovery's Growth Potential

- 5 sources consider Energy Recovery's PX technology revenue estimates aggressive but not unreasonable if it proves successful.

## Market Conditions and Competitive Landscape

- Market conditions are favorable for Energy Recovery in the CO2 refrigeration market, as 98% of the supermarket cooling systems in the U.S. still use HFCs and will need to be converted. Regulations including the AIM Act in the U.S. and the Kigali Amendment globally are driving the increased use of CO2 refrigeration.
- The wastewater treatment market has significant growth potential in the lithium industry. However, the regulatory environment is not as strict, which makes potential customers less inclined to try new solutions.
- OEMs and component manufacturers discussed as both potential partners and competitors of Energy Recovery include Hussman, Hillphoenix, Kysor Warren, Zero Zone, Enex SrL Su, Danfoss, Carel, Emerson, and Baltimore Aircoil in CO2 refrigeration. In the wastewater market, competitors and potential partners discussed were Veolia Environnement, Mitsubishi, and Kubota.

## 1) [Jim Knudsen](#), longtime refrigerant industry executive and strategic leadership consultant

Energy Recovery will have to demonstrate a significant value proposition when compared to competing technologies in order to achieve its growth plan. The PX technology for CO2 refrigeration is legitimate and unique, but a variety of approaches exist to solve the energy-savings problem that it has set out to solve. The ejector technology is its primary competitor, but there are others, such as [Epta's FTE technology](#). Both are widely used in Europe and also have a few implementations in the U.S. Energy Recovery will have to demonstrate that its pressure exchanger is reliable, that commercial controls for it are available, and that it is a better value than the technologies of competitors. Energy Recovery would benefit from creating relationships with OEMs and consulting engineers to build confidence in its product and to sell to end users. Energy Recovery's growth projections are aggressive. But selling \$100 million of its product worldwide is not an unreasonable goal, especially if it can penetrate other global markets, such as Europe. However, this adds complexity because of different standards and business cultures. Still, unless Energy Recovery can demonstrate a strong value proposition, it will be difficult to penetrate the industry.

### Background

- Consultant. Used to be with Danfoss. He has looked at Energy Recovery's technology.

### Energy Recovery's PX Technology for CO2 Refrigeration

- "I've looked at the technology, and I talked to Energy Recovery at the [ATMO America Conference](#). I understand the technology behind it and the reason why. It seeks to solve a problem that exists in the CO2 transcritical system. In CO2 systems, the gas cooler replaces the condenser in a traditional refrigeration system. After the gas cooler, you drop the pressure so that the liquid CO2 condenses, and you can operate the system at more reasonable pressures. In the process of dropping the pressure, you throw away some work that reduces the efficiency of the system. If you can recover that pressure in some way, you can make the system more efficient. The Energy Recovery device is an attempt to do that."
- "The technology exists in the desalinization business, and now they are looking to see if they can apply it to transcritical refrigeration."
- "The science is absolutely legitimate. It's not the only way to do what they are trying to do, but it is legitimate. It also has competitors."

- “There are several different devices that seek to do pretty much the same thing as this does. One of the most popular is the ejector. An example of an ejector is the device that sucks up the soap on the hose attachment that draws soap out of a container and sprays it on the car. Ejectors have been around for a long time. The technology is very well-understood. It’s a solid-state device, and there are no moving parts.”
- “Some companies have implemented it to try to do the same thing—to utilize the work that you lose in the transcritical pressure drop to do some other work in the system and save that energy.”
- “For Energy Recovery, the key questions will be how expensive it is and how reliable it is. If it can compete with those other devices from an expense and reliability standpoint, it has a chance.”
- “Complexity of how it can be controlled is also an issue—if there are commercial controls available to utilize it within the system. Those are all questions that need to be answered.”
- “The ejector is the biggest competitor.”
- “Other competitors are beginning to use [subcoolers](#). That uses some of the energy within the system or uses a separate system to drop the temperature of the gas coming out of the gas cooler even further, so that the need for the amount of energy lost through the transcritical valve is less. The lower that work loss is, the less need you have for this type of technology.”
- “[Epta is deploying](#) something like this. [Danfoss](#) and [Carel](#) each have ejector technologies. They are each a little different from each other, but they roughly do the same thing.”
- “There is yet another technology that doesn’t do the same thing, but it accomplishes some of the end-use goals. That’s Epta’s FTE, which is a way to improve the efficiency of the display cases and the refrigeration evaporators in the store. And it provides an energy savings that is roughly the same as that from Energy Recovery’s pressure exchange PX G1300 technology.”
- “One could argue that if you’re getting an energy savings, it doesn’t matter where it comes from.”
- “Energy savings is also key in the gas cooler. There are companies selling adiabatic or water-cooled gas coolers. They use water evaporation to drop the temperature of the gas in order to save some energy in that process. It doesn’t accomplish the same thing that PX G1300 does, but it mitigates the need for it. The primary company making those is Baltimore Aircoil.”
- “All of these products have been used. The adiabatic gas coolers are reasonably popular in the U.S. In Europe, ejectors and FTE systems are in wide use. In the U.S., we are still in the infancy of CO2 refrigeration. There aren’t as many applications as in Europe. But there are a few ejector, FTE, and adiabatic condenser implementations in the U.S.”
- “The key to success for Energy Recovery’s device is, most importantly, how reliable it is and if it can be controlled with the control systems that are available for CO2 systems. The area of controls is one that component manufacturers don’t address many times, but it’s extremely important. If you don’t have robust controls for a particular device, it’s going to be very difficult to implement.”
- “This is something new and different. People will have to learn about it and gain confidence with it. They have to be able to go somewhere to see it demonstrated so they can look at it and verify that it works.”
- “It would be very useful if a controls manufacturer like Danfoss or Carel or Emerson would put their name behind it, if they would say they understand this piece of equipment, and they can control it with their controls, and it works. Emerson would be the big name there. However, since it competes directly with products that both Carel and Danfoss sell, it may be a longer putt for them to verify it.”
- “In my opinion, unless they can show a significant value compared to the competing technologies, it’s going to be very difficult for them to penetrate.”
- “It’s such a different technology, and people are so unfamiliar with it, that it would really take a lot.”
- “It’s a conservative industry. People are still doing test stores for basic CO2 systems when there are tens of thousands of installations already in Europe that fully demonstrate that the concept works. But it hasn’t worked for them, so they have to do their own tests. That test store has to operate for a number of years before they are confident that it will work. To bring in a new device like this is to risk their whole commercial establishment on this device. Unless there’s a substantial value proposition above the competitive technology, it’s going to be a tough one.”
- “I used to sell ejectors when I worked for Danfoss. Getting people to accept that was difficult even though it’s very simple and very well-established. You have to sell people on CO2 first, and then you have to sell them on the

**“In my opinion, unless they can show a significant value compared to the competing technologies, it’s going to be very difficult for them to penetrate.”**

Jim Knudsen, longtime refrigerant industry executive and strategic leadership consultant

different technologies. Then you have to talk about brands and controls. It's a difficult sell. Unless it's an overwhelming value proposition, it's going to be a difficult push."

- "Assuming they're successful, it could take 10 years."
- "They have to take into account a number of different constituents. They might want to spend time with the OEMs, such as Hussman, Hillphoenix, Kysor Warren, and Zero Zone. If I were Energy Recovery, I would invest a lot of time in the consulting-engineering space, the engineers who are designing the system for the retailers. If they can sell the consulting engineers, selling to chains is going to be easier. Their salespeople need to be technical experts who can call on consulting engineers to convince them of the value proposition for their clients. They also need people calling on the OEMs to help them understand how to sell it and how to implement it. They also need people to call on the end users to make sure they're confident that if they test it and implement it, it's going to be a reliable solution for them."
- "Energy Recovery's device is unique, but it's not the only way to solve the problem."

### **Energy Recovery's Growth Potential**

- "CO2 is just being implemented, and it won't be fully implemented by 2026. Energy Recovery's TAM figure [that you cite, reaching \$100 million by 2026] for its CO2 refrigeration products [is] very aggressive, maybe 10 times more than what could be expected."
- "Available funding from government or electric utilities could help their cause. Literally billions would be required for food retailers to meet targets like the ones set by the California Air Resources Board."
- "I don't want to rain on anybody's parade, but for example, the total business of an OEM—for example, Zero Zone, which makes the whole refrigeration system for food retailers—I'm guessing is around or under \$100 million, with probably a 10% market share."
- "\$100 million for this product is not unreasonable worldwide, particularly if they begin to penetrate the European market. However, that would add a great deal of complexity, because that involves different standards and the different cultures and ways of selling in Europe, Asia, South America to the various different portions of the industry. It's great to have that goal, if they have plans behind it."
- "This device does address a particular need in the marketplace. The question is, what's the value proposition? How does it compare to other ways of doing it? As a salesperson, that's how I think of these things."
- "I used to work in wastewater treatment. I think this device probably has a good application there."

### **Market Conditions and Competitive Landscape**

- "The North American refrigeration systems market—retail-only, including grocery stores and some other food storage applications—is about \$1.5 billion, in my estimate. That includes everything—compressors, valves, and all the components you need to build a refrigeration system. Energy Recovery's pressure exchanger is just a component of that. What percentage of a system's cost does the cost of this device make up? One percent, maybe?"
- "The addressable market for food retail, which is probably the largest market for CO2 in North America, is probably around \$150 million, perhaps somewhat more, for the entire CO2 systems. And it is a big market. And the CO2 market is the biggest by far—is maybe \$150 million in the U.S. for all refrigeration systems, not just CO2."

## **2) Executive with a refrigeration industry organization**

Technologies like Energy Recovery's PX are already being used successfully in Europe, where about 80% of supermarkets have adopted CO2 refrigeration. OEMs there, such as Epta, are already using energy-enhancing technologies that are built into refrigeration systems. Energy Recovery's market potential in the United States is tremendous, as European companies may have little appetite to enter the market. Still, Energy Recovery will need to show third-party validated data to penetrate the market. They will also need to establish relationships with OEMs, which it is beginning to do. Also, the company will have to create a cost-benefit analysis to show ROI. About 98% of U.S. supermarkets are still using climate-damaging HFC refrigerants. The AIM Act is expected to phase down the production and consumption of these HFCs by 85% by 2036. This will drive U.S. supermarkets to switch to climate-neutral refrigerants such as CO2, making the 10-year outlook for CO2 refrigeration good as supermarkets convert their stores. To succeed in this market, Energy Recovery will have to prove its technology and ROI.

### **Background**

- Industry organization executive



## Energy Recovery's PX Technology for CO2 Refrigeration

- “The ejector technology, which is similar to what Energy Recovery is promoting, is pretty much standard in Europe now. In Europe, there are manufacturers who build it into the system. Here, it's still at a premium and essentially untested.”
- “Out of approximately 65,000 grocery stores and supermarkets, there are about [1,000 CO2 transcritical supermarket systems in the U.S.](#)”

## Energy Recovery's Growth Potential

- “The situation in the U.S. is very different from elsewhere globally. We have a very low adoption rate of climate-friendly refrigerants. About 98% of supermarkets in the U.S. are still using climate-damaging HFC refrigerants, and less than 2% are using CO2 and other climate-neutral refrigerants. In Europe, that's flip-flopped. The adoption rate of CO2 is at 80% over there, while 20% are still using HFCs or fluorinated gases.”
- “In those terms, there's a tremendous potential. The change in Europe has happened relatively quickly in the last decade. It is possible that we could get to a mass adoption of climate-friendly refrigerants in a short amount of time.”
- “We finally have regulations in the U.S. that are starting to require this transition. The AIM Act mirrors the Kigali Amendment, the international treaty that practically all other nations are following globally and which is driving the phase-down [of climate-damaging refrigerants] in Europe. The AIM Act will phase down the production and consumption of HFC refrigerants by 85% by 2036.”
- “The 2036 date is already creating pressure for grocery retailers. The phase-down will make the supply of HFC gases go down. There will be a very limited supply of HFCs—not enough to fulfill the demand there is today.”
- “The 2036 deadline is going to put tremendous economic pressure on retailers to transition away from HFCs. It's going to make the price of HFCs go up. There will be price pressure if demand continues to stay the same [when] supply goes down. Many retailers will need to transition to a different refrigerant.”
- “This is not as simple as just replacing the gas. You have to replace the entire equipment. Many retailers are looking at CO2 as a standard solution. When they build new stores, they are building them with CO2. Also, we are now seeing more often that when they replace their systems, they're using CO2. CO2 is seen as the best natural refrigerant because it is nonflammable, and it is nontoxic. Other refrigerants, like ammonia, are toxic. Hydrocarbons like propane are flammable. CO2 is seen by many retailers as the safest and most neutral refrigerant to use.”
- “Not a lot of options are available that are market-ready besides natural refrigerants. However, natural refrigerants like CO2 require that the entire system be changed. You can't just drop in the gas, as was previously done with replacing ozone-depleting refrigerants—the previous wave of refrigerants that we replaced with HFCs. We unintentionally created a different disaster, from the ozone-layer disaster to the climate-change disaster.”
- “The big expense will be when grocery chains will have to retrofit their existing stores. They will have to replace entire systems and pieces of equipment.”
- “The main reason adoption has been so low in the U.S. is because there weren't any regulations.”
- “Another challenge is a big technician shortage in the workforce that needs to install, maintain, and service the systems.”
- “There is also a lack of technology. Compared with technologies that are available in Europe, there are far fewer companies offering far less advanced technologies in the U.S.”

## Market Conditions and Competitive Landscape

- “There is already a success story. We are seeing better technologies all over the world with improved energy performance. The technology exists, but it needs to come here and be adopted.”
- “In the U.S., the market potential is that there is a low adoption rate [of CO2 refrigeration systems]. That, combined with federal and state regulations, is going to be driving this transition.”
- “Energy Recovery will need third-party verified or validated data on their energy performance.”
- “Energy Recovery needs to work with the OEMs to have their technology built into their system. They can't go directly to the customer and have the customer purchase the equipment from them. The customer needs to specify it in the system they order. [I understand they are starting to have some OEM relationships].”

“Energy Recovery will need third-party verified or validated data on their energy performance. ... Energy Recovery needs to work with the OEMs to have their technology built into their system. They can't go directly to the customer and have the customer purchase the equipment from them. The customer needs to specify it in the system they order.”

Executive with a refrigeration industry organization

- “It would be hard for the Europeans to come here to sell their technology. You have to have relationships with the OEMs that assemble the technology. As the dominant players, they are protective of their technology. It’s also expensive for a European company to come here. They would have to do all the R&D work to convert the system to the different voltage that we use in the U.S. Listing, testing, and credentialing can take a long time. It’s a big investment. With the supply chain issues, I don’t think anybody is looking to add to production now.”
- “In the U.S., the major CO2 system OEMs are Hillphoenix, Hussman, Zero Zone, and Kysor Warren Epta.”
- “Epta is a European company that builds in an ejector standard with their CO2 system—the FTE technology. It has an ejector built in and not an add-on component to the basic system. FTE also helps with energy performance.”
- “Epta’s system would be more expensive [to bring here] and would make it harder to justify the upfront cost.”
- “The main challenge with CO2 systems is that they do not perform as well in warmer climates. There’s an energy penalty. The system has the potential to use more energy. In Europe, that means south of the Alps. In the U.S., it’s only the northern states that don’t have this issue, but even they have issues in the summer.”
- “To make CO2 the most viable technology, this energy penalty needs to be addressed, because energy is very expensive. A technology that works would be very promising.”
- “Danfoss, a Danish company with a U.S. presence, is the main competitor as far as I know. But they are having trouble with their ejector technology. They have tried to pilot it, but it hasn’t been successful. I don’t know the exact details, but the lab results have not been favorable in their work with the OEMs. The technology works very well in Europe.”
- “Some of the other major OEMs in Europe are Advansor, owned by Hillphoenix, and Enex.”
- “From the retail perspective, the two most important questions are if Energy Recovery’s technology works, and what the cost is. They will have to make a cost-benefit analysis to see if it’s worth it.”
- “The main activity with CO2 refrigeration is new stores that are being built. However, new store growth year over year is not very high, maybe 1% or 2% annually. The bigger opportunity is with all the existing stores that need to convert. My guess is that’s going to happen over the next 10 years. It will be slow to ramp up, will hit a tipping point, and then it will accelerate very quickly.”
- “The 10-year outlook [for CO2 refrigeration] is very good. Things move very slowly in this industry, so it’s hard to say if things will pick up faster.”

### 3) Research and development associate with Oak Ridge National Laboratory

Although this source has not seen Energy Recovery’s PX technology in person, he has evaluated the online simulation. He said CO2 refrigeration has a promising future, as it is environmentally friendly. He noted that CO2 systems work best in colder climates.

#### Background

- R&D associate staff, Oak Ridge National Laboratory
- Co-author of [“Pressure Exchanger for Energy Recovery in a Trans-Critical CO2 Refrigeration System.”](#) published in Energies.
- Has not seen the product in person but reviewed the online simulation.

#### Energy Recovery’s PX Technology for CO2 Refrigeration

- “This recovery system works entirely differently than any available technology simply because the system is exchanging flow energy, not thermal energy only. This will give this technology an edge over its peers.”

#### Energy Recovery’s Growth Potential

- Realistic to have a viable impact on the market by 2030? “This is a reasonable expectation.”

#### Market Conditions and Competitive Landscape

- “In the renewable-energy industry, CO2 is really not much different from the other conventional refrigeration systems; just the operating pressure is different. It has a higher operating pressure because of the gas nature; that is how the pneumatic cycle works. That is not a big issue. It might raise some safety concerns, but this kind of risk has been always dealt with in different applications, so it shouldn’t be a problem.”

“This recovery system works entirely differently than any available technology simply because the system is exchanging flow energy, not thermal energy only. This will give this technology an edge over its peers.”

Research and development associate  
with Oak Ridge National Laboratory

- “In general, any heat-pump efficiency drops in cold ambient conditions. When it comes to CO2 systems, it is found that they perform better in cold climates. The reason is that the operating temperatures of CO2 inside the refrigeration systems are different than the other conventional refrigerants. This will allow in higher temperature difference and higher efficiency as a result.”
- “CO2 is a natural refrigerant, and it is the best in terms of being environmentally friendly. ... I believe it will have a big share of the market.”

## Miscellaneous

- “CO2 systems will improve their efficiency, without a doubt. However, the technology is still young and needs to mature to be applied widely. There is work still to be done.”

## 4) [Sam Shelby](#), president of Advent Technology LLC and an industrial wastewater treatment expert

Energy Recovery’s application for wastewater treatment seems legitimate. And its projected application in lithium, which is new and flourishing, will provide them growth opportunities. To grow, the company will have to provide examples of pilot projects and demonstrate energy savings. The capital cost of its installation will also be a major factor. Creating partnerships with end users would allow Energy Recovery to demonstrate that the product works. In the market, they face stiff economic competition from mature and demonstrated technologies. Companies such as Veolia would be a major competitor. Capturing \$30 million to \$70 million in sales by 2026 is a viable target, but they need to be extremely successful to achieve that.

## Background

- Worked his whole career in industrial wastewater treatment.
- He looked at Energy Recovery’s product when informed of the topic of this interview.

## Energy Recovery’s PX Technology for Wastewater Treatment

- “I do think the science behind it seems legitimate. It could work.”
- “The technology is in a growing field, but there are limited applications for their technology at this time.”
- “Lithium is new and growing. There are mines and brine fields. It will be a great industry to jump into. It’s going to really flourish in the future.”
- “It seems the technology can work, but I haven’t seen a case or place where it’s working that Energy Recovery is listing on their website. Most companies are proud to list their installations and applications, even if it’s pilot-scale. I don’t see that for them. They do seem to have some history [in desalination], and they should be advertising it.”
- “They will also have to demonstrate the significant energy consumption advantages that they say they offer.”
- “However, energy consumption is only one factor that the industry looks at. Industry also looks at the capital cost. If it consumes low energy, but it costs a fortune to install it, that’s probably a no-go for a lot of companies.”
- “In my experience, when we built new technologies, we partnered with industries to help us develop the technology, run a pilot, and work on all the aspects of the design.”
- “Energy Recovery needs something like that—to convince, let’s say, a lithium company that they have the right technology.”
- “The other thing would be partnerships with engineers that the end users hire for an installation.”
- “They say they can build small scale. Desalination is very large scale, so saying they can build small scale indicates they have something. If they can demonstrate on a small scale, they can ultimately get into larger scales.”
- “In terms of how long, if they go from less than \$1 million in sales now, and if they click in the lithium industry, and the industry expands like it’s projected to, they could probably do that in five years. But they do need to be extremely successful to reach \$30 [million] to \$70 million in five years. There are organizational issues and manufacturing issues. It’s not just checking a box and delivering the system. You have to deliver the goods and make them work.”
- “There are mines in Argentina, brine fields in Chile; California has enacted legislation to end the sales of new gasoline cars. The mega water drought in the Southwest can be a driver. Penetrating the petrochemical and pharmaceutical industrial market would be difficult, however—but they can, although there are many ways to foul

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Sam Shelby, president of Advent Technology LLC and an industrial wastewater treatment expert

things up. If they are able to get investors in companies like in China and India, where this sort of technology might make good sense, and have good partners, they could pull it off.”

- “Any potential user would probably have technical questions that they would need to know about. Those would have to get satisfactorily answered and demonstrated.”
- “If they have applications, these will be the first applications on what is a relatively new and emerging technology. They have to demonstrate it with new and emerging and limited applications and get it accepted that way.”

#### **Energy Recovery’s Growth Potential**

- “The TAM of \$1 billion to \$3 billion might be the global market. Those are big numbers, but I’m not a market analyst.”
- “Again, based on their web page, they don’t have any demonstration of installations. Capturing \$30 [million] to \$70 million in four years is a viable target.”

#### **Market Conditions and Competitive Landscape**

- “The competition they will be facing will be stiff, ... with demonstrated technology. They are going to have to knock off some big boys. They will have to find some clients that really believe in them—the right place, the right size, and the right application.”
- “Veolia would be one of their major competitors.”

### 5) Senior engineer and sales executive with a wastewater treatment engineering firm

Energy Recovery’s product for wastewater treatment should work, but the bigger question that remains is whether it can convince potential buyers and users that their energy savings are worthwhile. Energy cost savings is usually not part of the decision-making process when building wastewater treatment facilities. Because PX is a unique device—though there are other ways to achieve what they want to achieve—with no real competitors, potential users would worry about relying on one company alone for this product. Energy Recovery’s revenue projections are high. If it can make that kind of revenue, it would very quickly have major competitors. Wastewater treatment technologies are still evolving. It is important to remember that wastewater treatment is a low-margin but high-risk business. There is little appetite for risk. To advance their technology, Energy Recovery might look for buyers such as Mitsubishi or Kubota. Or they could find existing facilities and offer the technology for a fee, with a guarantee that it will pay for itself after three years. The company would benefit from finding locations where energy costs are high.

#### **Background**

- They are systems integrators in wastewater.
- Hadn’t heard of PX before but looked at the link after it was sent to them.

#### **Energy Recovery’s PX Technology for Wastewater Treatment**

- “There are two major issues with reverse osmosis [RO] or with any membrane process: the energy consumption and the other [operation and maintenance] costs, like backwashing, clean-in-place, membrane replacement, and things like that.”
- “My first inclination is that if something like this were to work, it only addresses part of that problem.”
- “When you have to purify water by forcing the water through tiny little holes, it takes a ton of energy. You get good water quality on the back end, but you create very aggressive brine. You’ve spent a lot of money on electricity and different moving parts like pumps.”
- “I understand that this product works by taking the brine stream, the reject that comes off the unit, and recovering energy off of that pressure. The PX device transfers energy from high-pressure brine to seawater, and then there’s a recirculation pump that brings that back to the membranes.”
- “There are a lot of ways to convert pressure energy into electrical power. But they have also added a circulation pump into the process, which adds to the power consumption required.”
- “It probably works. But will it shift the needle on the decision-making process? That I don’t know.”
- “This device can also introduce several points of failure into your system. If anything breaks in that pressure exchange, it can cause issues, all for a little bit of energy savings. The question is if it’s worth it.”
- “The device seems very unique. We can say that it works. But there are lots of systems in the world that will take waste energy and convert it into useful energy. Electric cars are an example of this. They take waste energy and recover it through the braking system and regenerate the battery. Energy recovery on waste streams is a common idea, and we know that it works. It comes in a lot of different forms. But something working is different from it being a good idea.”

- "There are other pressures involved. Because it's such a unique device, and because there's no competition, you have to rely on this supplier only. There could be costing issues and supply chain issues. Replacing it could be a big issue. These are all decision factors when you are implementing new technology."

## Energy Recovery's Growth Potential

- "That TAM seems very high."
- "We don't know the cost of the unit [so can't calculate revenue]."
- "That would be a heck of a revenue."
- "In their projected revenue figures, is the cost-benefit ratio skewed heavily to the benefit side?"
- "I don't see them on any kind of Google patents. But they must have one."
- "They could maybe have a temporary monopoly of the market."
- "It does seem like a fairly simple device. If they would be pulling in that kind of money [their revenue forecasts], they would instantly have major competition."

## Market Conditions and Competitive Landscape

- "We're a system integrator. We don't work with a lot of reverse osmosis. RO is less common on the wastewater side than with drinking water."
- "A device like Energy Recovery's pressure exchanger could be useful also in the membrane bioreactor industry. They're related. But those industries are still fledgling; they're not mainstream. They are battling with net present value analyses that engineers are doing. Those engineers are finding that unless they need to have a very tiny footprint for their plant, there's no point in spending the extra money."
- "With wastewater, the issue is that the regulatory infrastructure does not exist to drive tight effluent limits for every project. Most projects don't have tight limits. Membranes exist for making the super tight limits. The regulatory driver is not necessarily there. It's growing, but it's not mature."
- "The other side of the issue is that the state of the technology is always improving. That indicates it's not a mature technology but an entry-level type of technology. It's similar to the cellphone market, and in those terms, we would be at about the point where we would be about to introduce the iPhone. The older technology is being phased out, and they are inventing new things very quickly. Everybody says their invention is the best. It can take another 10 years before we figure out what the real technology survivors are going to be."
- "We build large wastewater treatment plants, and the energy cost savings aspect is almost a back-end conversation. Energy efficiency is not part of the decision-making process. Putting this device into a facility for the energy savings would not be part of the decision-making process."
- "The question someone buying this product would be asking is how much energy would it save them, at this price point, so they could recover the cost of buying that product."
- "We've seen companies having ambitious goals in the wastewater market. Ten to 15 years ago, major wastewater companies were buying up all the little ones. We dream that it's going to be a huge market, and it's life-changing for everybody. But we tend to forget that it's a low-margin and high-risk type of business. There aren't a lot of paradigm shifters out there anymore. A product like this is attempting to shift the paradigm."
- "They may end up becoming part of the solution, but it seems [at a glance] like their projections are maybe a little overblown."
- "I've been an early adopter of some technologies, and they didn't work out. I don't have the risk tolerance of being an early adopter anymore."
- "If they are looking for buyers for their technology, it would be RO manufacturers, such as Mitsubishi and Kubota."
- "The other way to develop their business is to find existing facilities where they present their solution with some net payoff within, let's say, three years, if it works. If it works that well, it should sell itself. They would get \$50,000 in exchange for the Energy Recovery device and promise the company that they would recover that \$50,000 within three years. Companies like that kind of deal because after year three, they are making money off the deal."
- "Also, targeting the highest energy-cost markets would be helpful."
- "Energy costs would have to be very high to make a device like this viable."

"They may end up becoming part of the solution, but it seems [at a glance] like their projections are maybe a little overblown."

Senior engineer and sales executive  
with a wastewater treatment  
engineering firm

## Miscellaneous

- "I like it that there are people out there risking their money on products like this to try to push the envelope on water quality and energy savings. There is definitely a space for people to try to do that. If people with money want to take a shot, that's great."

- “Developing a product like this is hugely expensive—to figure out how to do the engineering behind it, to go about the manufacturing, to figure out how it’s going to be built, and still recover your costs and be profitable on the back end, particularly if there’s no regulatory framework pushing it. They could potentially change the market. They could write the script on it.”

## Secondary Sources

This secondary source focused on Energy Recovery’s debut of the PX G1300.

### June 3 R744 CO2 Cooling Marketplace [article](#)

Energy Recovery is on the verge of marketing a pressure exchanger designed to significantly improve the efficiency of transcritical CO<sub>2</sub> (R744) refrigeration systems in high-ambient-temperature locations.

- “[Energy Recovery, Inc.](#), a San Leandro, California (U.S.)-based manufacturer of pressure-exchanger devices, is ‘very close’ to marketing a pressure exchanger designed to significantly improve the efficiency of transcritical CO<sub>2</sub> (R744) refrigeration systems in high-ambient-temperature locations.”
- “The transcritical CO<sub>2</sub> pressure exchanger device, [model PX G1300](#), uses high-pressure gas from the gas cooler to boost the pressure of low-pressure flash bypass gas, explained K.C. Chen, vice president of engineering for Energy Recovery. The now higher pressure gas can then be channeled back to the gas cooler rather than to the medium-temperature compressor, thereby saving energy.”
- “Energy Recovery has determined that the PX G1300 can boost the efficiency (COP) of a standard transcritical CO<sub>2</sub> system by up to 50% at 90° F (32.2° C).”
- “The device consists of only four pieces, a rotor and three stators containing an array of channels arranged around the axis of the rotor.”
- “With the design of the system in place, the company is in ‘the early stages of engagement’ with potential commercial partners—CO<sub>2</sub> refrigeration OEMs,’ said Chen. ‘We are very close to going to market.’ He added that the PX G1300 will be ‘competitively priced.’ ”
- “Energy Recovery has marketed its pressure exchanger technology over the past 30 years in the desalination industry. The device can recover up to 60% of otherwise wasted energy in the seawater reverse osmosis (SWRO) desalination process, noted Chen.”
- “Energy Recovery decided to develop the refrigeration application after being approached by Oak Ridge National Laboratory, which had done research into using a pressure exchanger to improve the efficiency of a CO<sub>2</sub> refrigeration system.”
- “Chen describes the PX G1300 as ‘almost like a revolving door’ facilitating a direct pressure-to-pressure exchange of energy, with a high pressure stream elevating the pressure of a low-pressure stream. ‘And you can adjust how fast the door turns to accommodate different cooling capacities,’ he said.”
- “At the same time, high-pressure gas is also allowed to become low-pressure coolant channeled to the liquid receiver.”
- “The PX G1300 would be an alternative to existing technologies that enhance the efficiency of transcritical CO<sub>2</sub> systems in warm climates, such as an ejector or a parallel compressor. According to Efficient Energy, ejector technology typically manages ‘less than 200psi (14bar) of pressure differential boost,’ while the PX G1300 ‘is able to manage an unlimited differential boost as required by the system, and therefore continues to perform as temperatures rise.’ ”
- “Chen said that the PX G1300, by reducing energy use on transcritical CO<sub>2</sub> refrigeration, ‘aligns with our ESG [environmental, social and governance] initiative completely.’ Energy Recovery’s [inaugural ESG report](#) was recently shortlisted for ‘Best 1<sup>st</sup> Time Sustainability Report’ by Corporate Register Reporting Awards, along with eight other corporations.”

Additional research by Eva Cahen, Eugenia Vlasova, Marianne Weaver.

# Energy Recovery Inc.

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