# POLAR ENGINEERING

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*Polar Engineering built a practice on a principle most facilities overlook: every time you cool something, you create heat worth capturing. From ice arenas in British Columbia to the two largest telescopes in the world, the Victoria firm has spent a decade proving how much of that energy has been going out the back wall.*

***Ian Welle founded Polar Engineering around a problem his clients kept describing to him. They could find engineering firms that handled grant applications, and they could find firms that did detailed refrigeration design. What they could not find was a single firm that did both, and that also understood energy recovery well enough to lead the conversation rather than follow it.****Polar was built to close that gap end to end: securing federal and provincial grant funding, performing the energy studies and carbon and electricity reduction analysis, delivering the detailed engineering, and commissioning the plant at the end. Welle came to it from Accent Refrigeration Systems, where he served as a principal engineer designing premium efficiency refrigeration and energy recovery systems for the ice rink industry, work that took him to projects on four continents.*

## ONE DISCIPLINE, MANY BUILDINGS

Polar's client list spans industrial food processing plants, ice arenas, curling clubs, hospitals, breweries, and large district energy developments. Asked what connects sectors that different, Welle's answer is immediate: industrial refrigeration is the entry point to nearly every project the firm takes on.
The engineering logic that follows is a matter of thermodynamics rather than sector. Cooling a fish processing facility, a brewery, or an ice sheet all produce the same byproduct.

The first question Polar asks is how to perform that cooling as efficiently as possible. The second, and the one that defines the firm's practice, is where the resulting heat can go so that a facility is not buying electricity or natural gas to produce warmth it has already generated and thrown away.


## TEN TO TWENTY HOMES PER ICE SHEET

Ice arenas and pools are Polar's core work, and they illustrate the scale of what conventional facilities discard. By Welle's rough order of magnitude, a single NHL-sized ice sheet produces enough waste heat to warm ten to twenty homes through a Canadian winter.

Most facilities send that heat straight outside. Welle points to a detail visible from the road at arenas across the country in midwinter: the plume rising from behind the building is heat being rejected to the atmosphere at cost. Polar's approach is to capture that heat instead, run it through a purpose-built heat pump that boosts it to as high as 90 degrees Celsius, and inject it directly into the boiler loops already serving the building. On a facility with two ice sheets and a pool, the firm typically cuts natural gas consumption, and the associated carbon emissions, by 60 to 80 percent.

The results at specific sites bear that out. At the Juan de Fuca Recreation Centre in Victoria, working with Westshore Parks and Recreation, Polar delivered a deep decarbonization program across two projects. An energy recovery dehumidifier servicing the natatorium now supplies over 60 percent of the heat required by the facility's pools, dressing rooms, and lobby, cutting natural gas use by more than 2,300 gigajoules and greenhouse gas emissions by 110 tonnes annually. A second project used a 1.9 million dollar grant to replace a heaved refrigerated floor and install a site-specific heat pump. The facility's overall natural gas consumption fell by 90 percent.

## REFRIGERATION AT ALTITUDE

Among the most technically demanding work in Polar's portfolio are the CO2 refrigeration systems Welle engineered for the two largest telescopes in the world: the Giant Magellan Telescope in Chile and the Thirty Meter Telescope in Hawaii.

The refrigeration components themselves, Welle notes, are not radically different from a conventional system, since the working fluid stays sealed within piping and never opens to atmosphere. The complication is elevation. At the altitudes both observatories occupy, air density and ambient temperature shift substantially, and any calculation involving absorbing heat from or rejecting heat to the surrounding environment has to account for it.

The harder constraint was what the telescopes could not tolerate. A conventional refrigeration system circulates oil throughout its entire length alongside the refrigerant, and it vibrates. Neither is acceptable on a precision optical instrument.

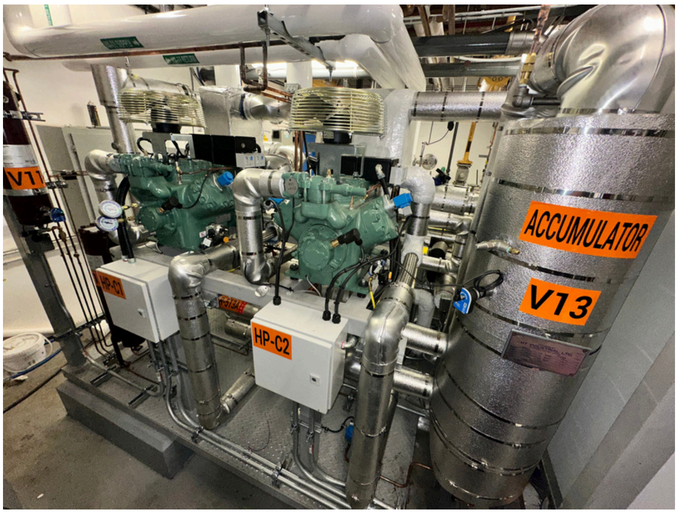
> *"The really cool part of those projects was that we could have no oil on the telescopes, and we could have zero vibration."*

Polar's solution was a split primary and secondary architecture. The secondary loop uses high-pressure liquid pumps to circulate liquid CO2 refrigerant through the facility, eliminating oil from the sensitive portion of the system entirely. For the Giant Magellan Telescope specifically, the firm designed a two-temperature refrigeration system built around exceptionally high pump discharge pressure, requiring a centrifugal pump capable of producing roughly 140 to 150 psi. Welle describes it as a daunting engineering problem that resolved well.

## THE FIRST OF ITS KIND IN NORTH AMERICA

Welle completed the first R515b heat pump installation in North America, in Oak Bay, Victoria, during his time at Accent Refrigeration. The significance is regulatory as much as technical. Refrigerant phase-outs underway in both Canada and the United States are pushing the entire industry toward refrigerants with low global warming potential, and many of the refrigerants capable of delivering the temperatures these applications require carried high GWP ratings.

The design objective was to achieve high condensing temperature potential while using a low GWP refrigerant, a combination that did not previously exist in commercially deployed form. Polar has since installed high-temperature, low-GWP heat pumps across Western Canada. In Prince George, a project replacing end-of-life ammonia plant equipment reduced the facility's ammonia charge by more than 70 percent and included what the City describes as Canada's first custom R515 high-temperature heat pump, designed to recover waste heat from the ice plant.




## THE BUILDINGS THAT ALREADY EXIST

Welle's argument for where the industry should focus is pointed. New construction receives the attention and the press releases, but the overwhelming majority of natural gas consumption over the coming decades will occur in buildings that are already standing.

The obstacle to retrofitting them was temperature. Existing institutional buildings typically run centralized hydronic boiler loops circulating water at 60 to 80 degrees Celsius. Until roughly five or six years ago, heat pumps could only reach condensing temperatures of 40 to 50 degrees, too low to integrate with that infrastructure.

High-temperature heat pumps changed the arithmetic. Rather than replacing a building's heating infrastructure, Polar can install a heat pump in parallel with the existing boilers, tapping directly into the loop already in place and shutting off the natural gas consumption behind it. The existing infrastructure stays, and the carbon reduction arrives at a fraction of the capital cost of a full replacement.

Proving that low-GWP refrigerants could deliver those temperatures while integrating with legacy hydronic systems is, in Welle's description, what Polar cut its teeth on over the past five to six years.

## THE GRANT CONVERSATION

Polar tracks available grant funding provincially across Alberta and British Columbia, where the firm works almost exclusively, and many clients approach the firm specifically for that capability. The reason is a straightforward tension in public sector capital planning: municipalities want to reduce consumption and be good stewards of their infrastructure, but they are spending taxpayer money and need paybacks that justify the investment.

Most communities Polar works with target a payback period somewhere between five and ten years, while the systems themselves last twenty to twenty-five. Grant funding is what closes the distance between those two numbers, turning a project that saves a community money over its lifetime into one that also clears the near-term financial test. Polar has secured funding at meaningful scale, including a 1.9 million dollar grant for the Juan de Fuca floor replacement and heat pump installation, and over 390,000 dollars in BC Hydro funding on a separate energy recovery project.

## WORKING AHEAD OF THE CODE

Refrigeration systems are inherently hazardous if designed incorrectly, and Polar works closely with Technical Safety BC, ABSA in Alberta, and the Ammonia Safety Training Institute. Both regulators treat the firm as a technical resource, which matters because Polar's work regularly outpaces the rules written to govern it.

> *"Polar is often doing the first ones in Canada, if not Western Canada. Sometimes the code doesn't apply to our systems very well."*

Welle compares the situation to the gap between artificial intelligence and the legislation meant to regulate it: the technology adapts faster than the statutes. Polar's practice in those cases is to work from the intent of the code rather than its literal text, sitting down with the regulator to establish what the provision was written to protect against and demonstrating how the proposed system achieves that protection. It is a relationship built deliberately on trust, and Welle is explicit about why it has to be. Protecting the environment and protecting the public are both non-negotiable, and the firm cannot trade one against the other.

## THE DEHUMIDIFIER NOBODY NOTICED

Asked which project felt like a genuine turning point, Welle points to a facility in British Columbia where Polar integrated a high-temperature, low-GWP heat pump with a new low-temperature desiccant dehumidifier, a pairing that had rarely if ever been executed in North America. Dehumidifiers are typically among the largest natural gas consumers in a recreation facility. This one was designed with no natural gas hookup at all. Nathaniel Green led the work from Polar's office.

The proof arrived accidentally. After commissioning, during maintenance on the heat pump, staff began receiving calls that the arena dehumidifier was not performing properly. Investigating, they discovered the natural gas backup system on the unit had never been commissioned in the first place.

## LISTEN FIRST, ENGINEER SECOND

Polar's stated operating principle is that the firm listens before it engineers, and Welle applies it as a screening mechanism as much as a service philosophy. The firm uses a design deliverable document at the outset of a project, asking clients directly what a good consultant looks like to them and what would constitute a win.

> *"If you're out for beers a year from now after finishing this project, what are the two things you say to your buddy about why you're glad you hired Polar? If you can tell me that on day one, we can deliver on it."*

The corollary is that Welle is comfortable declining work. Where a prospective client's needs do not align with Polar's expertise, he will say so and refer them elsewhere, on the reasoning that both parties end up better served.

## HIRING FOR VALUES, TRAINING FOR SKILL

Polar has grown into a team spanning detailed refrigeration design, grant and energy studies, and project engineering. Steffen leads the grant and energy study team and the detailed design work on hydronic system integration, complementing Welle's refrigeration lead. Tyler focuses on energy-efficient refrigeration systems that reduce operating costs and emissions.

The hiring standard is deliberately inverted from what a highly technical field might suggest. Polar hires for alignment with its core values and trains for technical capability, on the reasoning that anyone who has completed an engineering degree can learn a system.

> *"You can teach someone a technical skill. You can't teach them who they are on day one."*

The values themselves are specific: do what you say you will do; listen first and engineer second; operate collaboratively and recognize a good idea as a good idea regardless of who it came from.

## STEAM

Asked where the frontier is now, Welle answers without hesitation. The next generation of refrigerants is moving toward hydrocarbons, propane and isobutane among them, because they are what will make it possible to build heat pumps that exceed 100 degrees Celsius and produce low-pressure steam.

That threshold matters because a great deal of large infrastructure is heated by steam boilers and steam distribution, a category currently beyond the reach of heat pump technology. Polar attends conferences in Europe specifically to track where the industry is heading and how to lead that transition in North America.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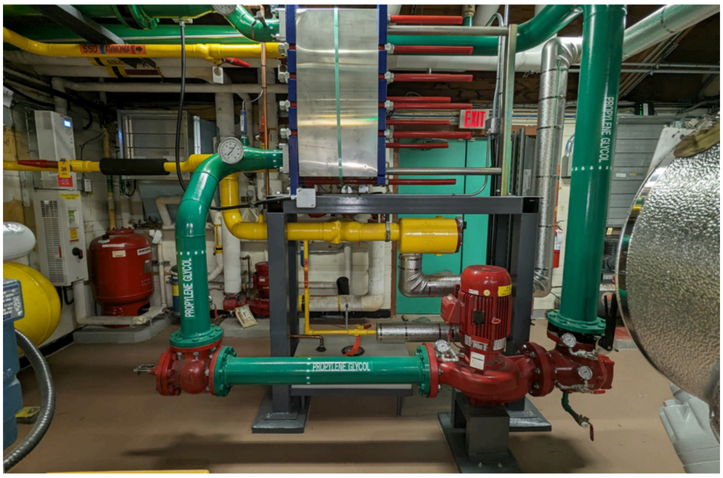
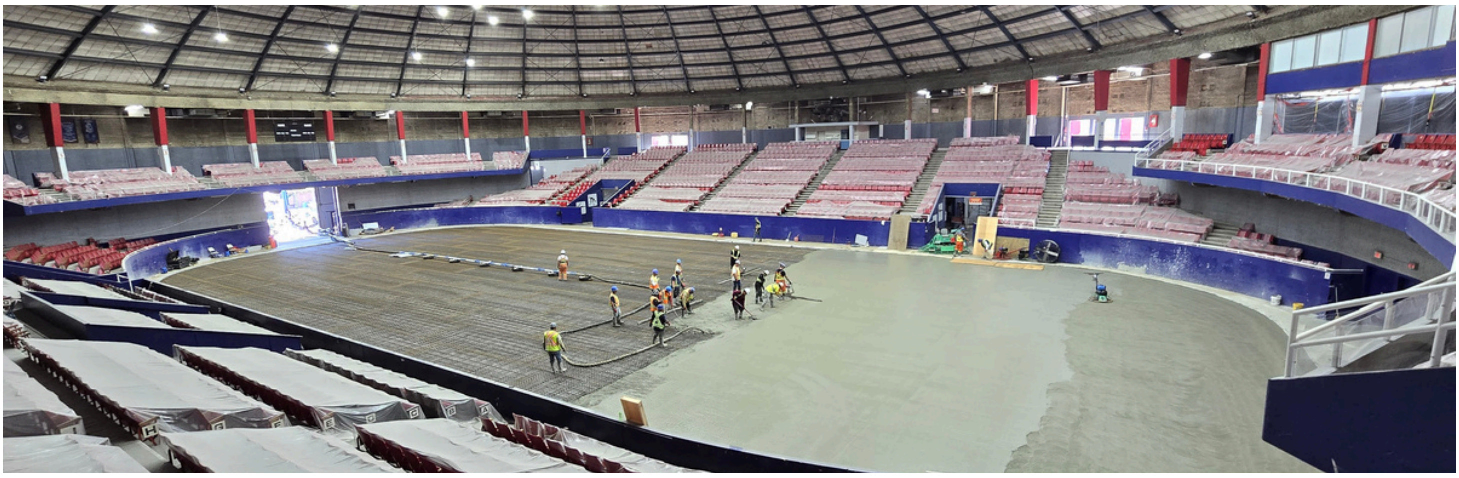


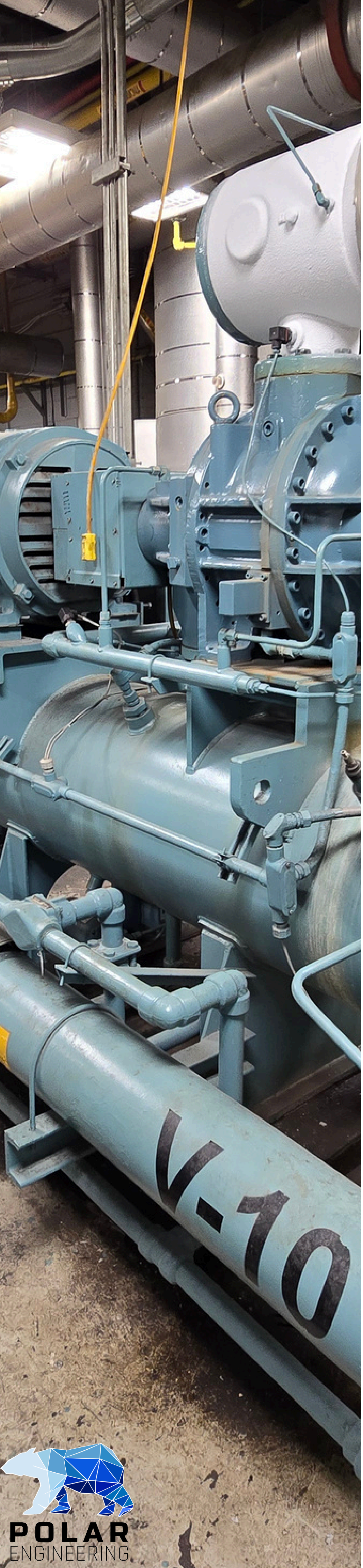


## READING WHERE THE MARKET IS HEADED

The engineering challenge comes attached to a safety one. Propane and isobutane are flammable, and the facilities these systems would serve are recreation centres and high-rise buildings occupied by the public. Welle returns to the same balance that governs the firm's regulatory work: the environmental objective and the public safety obligation both have to be met completely, and the industry will need to solve for both simultaneously as it makes the shift.

> *"Steam heat pumps are going to be the next big game changer in our industry. I'm excited to help lead the way for that in Canada and design systems that currently aren't possible to engineer."*

They are not commercially available anywhere today. A small number of test units exist in Europe. That, for Polar, is the point.





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