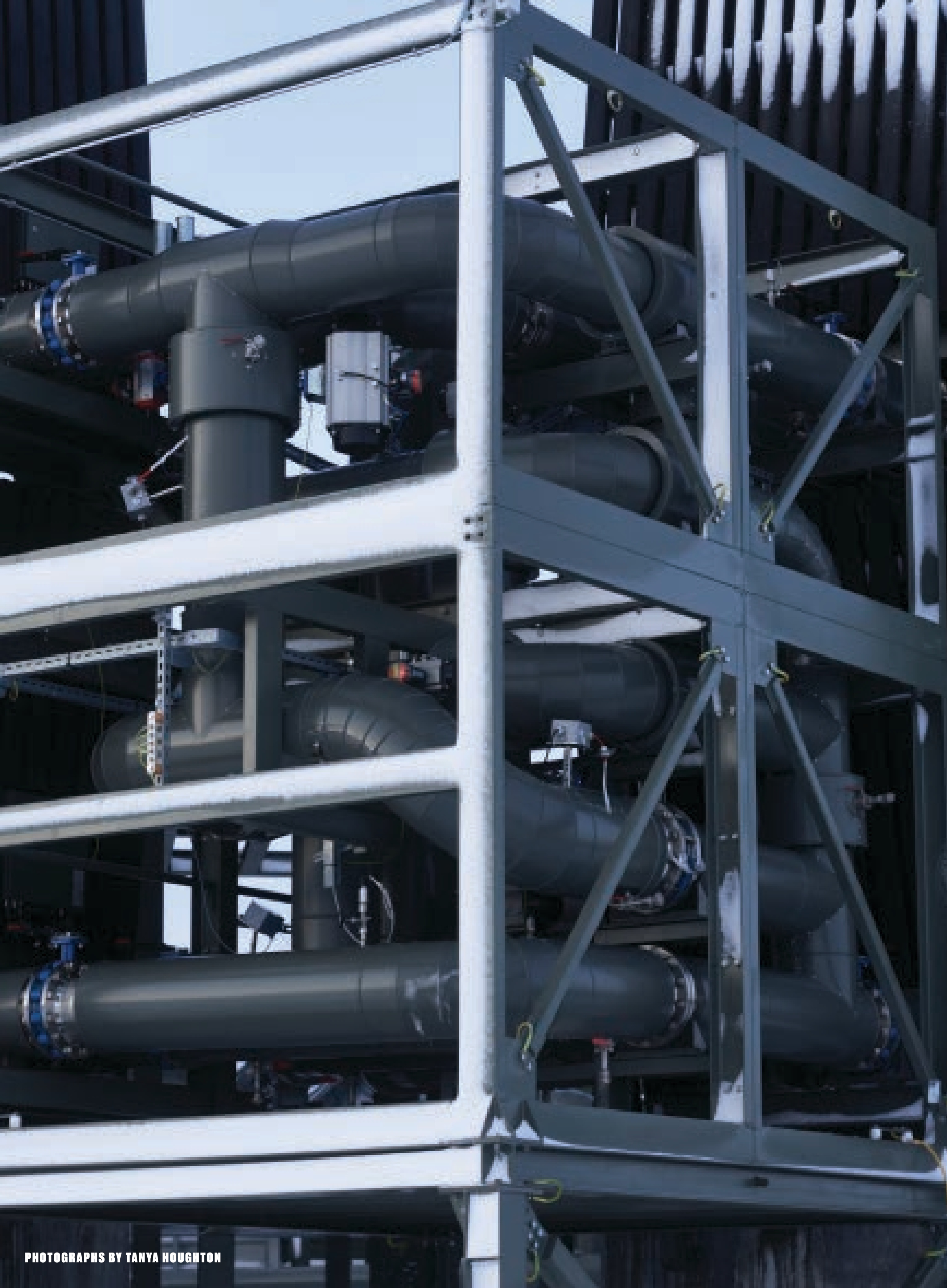
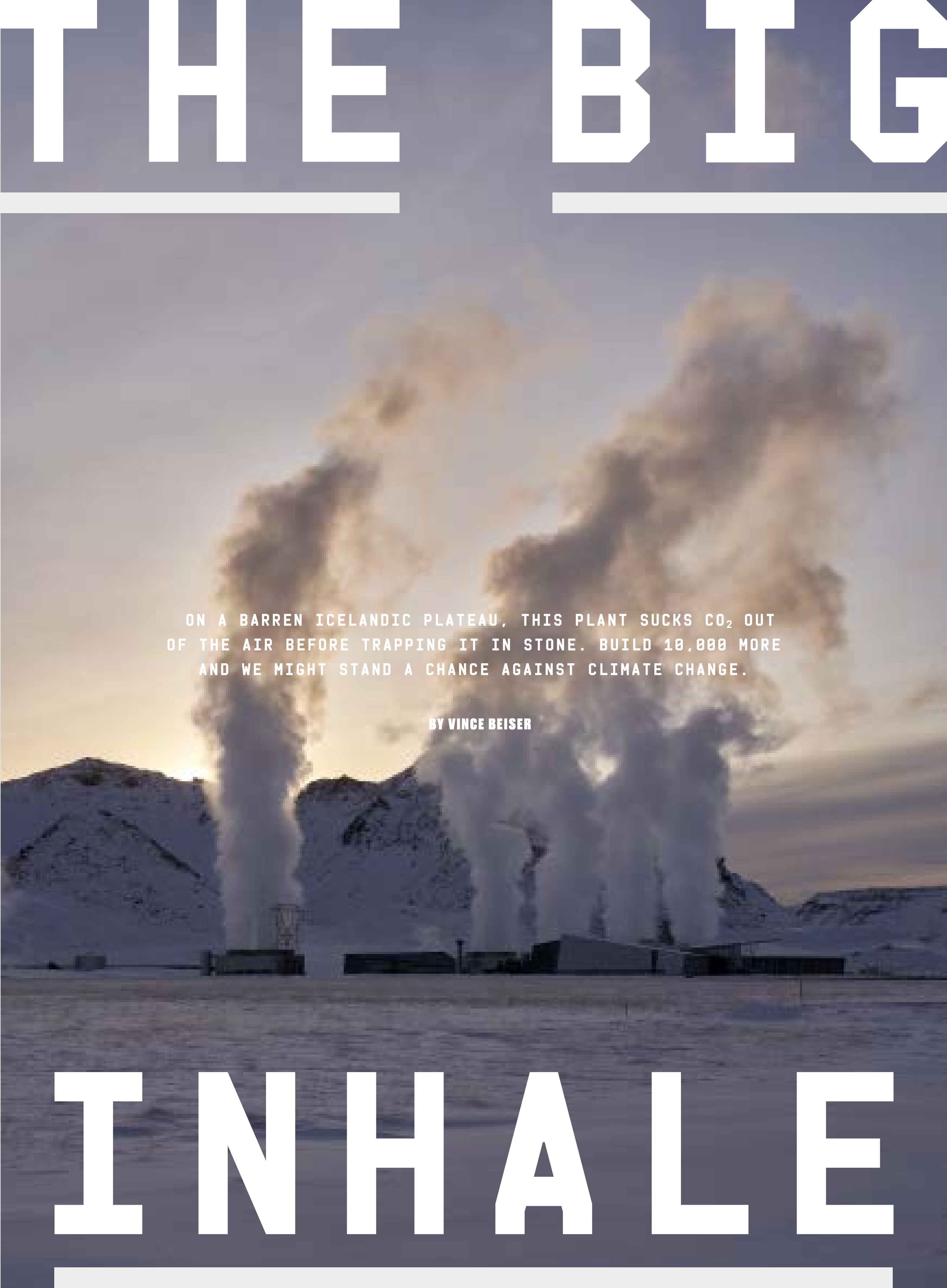


PHOTOGRAPHS BY TANYA HOUGHTON



THE BIG INHALE

ON A BARREN ICELANDIC PLATEAU, THIS PLANT SUCKS CO_2 OUT OF THE AIR BEFORE TRAPPING IT IN STONE. BUILD 10,000 MORE AND WE MIGHT STAND A CHANCE AGAINST CLIMATE CHANGE.

BY VINCE BEISER

IT WAS UNDOUBTEDLY THE MOST AUGUST GATHERING

EVER CONVENED ON THE UNINHABITED LAVA plains of Hellisheidi, Iceland. Some 200 guests were seated in the modernist three-story visitors' center of a geothermal power plant—the country's prime minister and an ex-president, journalists from New York and Paris, financiers from London and Geneva, and researchers and policy wonks from around the world. Floor-to-ceiling windows looked out on miles of moss-carpeted rock, luminously green in the September morning sunlight. Transmission towers marched away to the horizon, carrying energy from the power plant to the capital, Reykjavik, half an hour's drive away.

The occasion: the formal unveiling of the world's biggest machine for sucking carbon out of the air. The geothermally powered contraption represented a rare hopeful development in our climatically imperiled world—a way to not just limit carbon emissions but shift them into reverse. Prime Minister Katrín Jakobsdóttir declared it "an important step in the race to net zero greenhouse gas emissions." Former president Ólafur Ragnar Grímsson predicted that "future historians will write of the success of this project." Julio Friedmann, a prominent carbon expert at Columbia University, hailed it as "the birth of a new species" of planet-saving technology.

Jan Wurzbacher and Christoph Gebald, cofounders of Climeworks, the company behind the carbon capture plant, strode up to the front of the room together. The fresh-faced Germans, both 38, were dressed in nearly identical white shirts and blue suits. They spoke in well-rehearsed, Teutonically accented English. “This year could turn into a turning point in how climate change is perceived,” said Wurzbacher (slightly taller, stubbly brown beard). “Thirty years down the road, this can be one of the largest industries on the planet,” enthused Gebald (slightly broader, curly brown hair).

These are some mighty bold claims for a small industrial plant in a tiny, peripheral country. Climeworks’ facility is capable of pulling down only about 4,000 tons of carbon per year—an eye-dropper’s worth of the 40 *billion* tons the world emits annually. The plant uses a technique known as direct air capture, in which enormous fans suck in vast amounts of air from our despoiled atmosphere and run it over chemical-laden filters. It’s similar in principle to the tech that factories and refineries use to scrub CO_2 from their exhaust streams. But what’s potentially much better about direct air capture is that it can be deployed anywhere, and it removes carbon already in the atmosphere, whether it was belched out 10 years ago by a cement factory in Alabama or last week by a pickup truck in Zanzibar.

True believers have been trying to turn the idea into reality for at least 20 years. For most of that time they were ignored by investors, dismissed by scientists, and regarded with suspicion by environmentalists, who worry the technology will give businesses license to keep on polluting. Now the ground is shifting rapidly. The Climeworks facility is just the first of a handful of large direct air capture plants slated to go up in the next several years, propelled by nine-figure investments and the support of powerful allies, including in the US government.

An inflection point came in 2018, when the UN’s Intergovernmental Panel on Climate Change declared that the world will need to both cut new carbon emissions and somehow start reducing the amount of CO_2 already up in the air—and that direct air capture was a promising approach. The following year, Climeworks’ top competitor, Canada-based Carbon Engineering, raised over $80 million in private investment. In 2020, Climeworks pulled in more than $100 million. Several newer startups have also leapt into the arena, and for what it’s worth, in December Elon Musk tweeted that SpaceX is starting its own atmosphere-scrubbing program.

But direct air capture faces huge obstacles. Despite carbon’s enormous impact down at ground level, it is barely a trace element in the air—only about 415 out of every 1 million atmospheric particles are CO_2. Imagine putting a single drop of ink into an Olympic-size swimming pool; the challenge of direct air capture is akin to taking that drop back out. The cost is staggering: To pull in any meaningful amount of carbon requires armies of giant machines and titanic amounts of energy to run them. Then there is the question of how to get all that energy. If you burn carbon-spewing fossil fuels to run your carbon-capturing machines, you’re kind of defeating the point. Finally, there is the carbon itself; once you’ve gathered up a few million tons of CO_2, what do you do with it?

Oh, and one more thing to consider: Among the technology’s first beneficiaries might be oil and gas companies.

KLAUS LACKNER IS THE GUY WHO STARTED IT all. One summer evening back in 1992, Lackner, then a particle physicist at Los Alamos National Laboratory, was in his living room, knocking back beers with a friend and lamenting how no one seemed to be going after big, audacious science projects anymore. As the night wore on, they came up with one of their own—a system of solar-powered machines that would autonomously harvest raw materials from common dirt, use them to build more machines, and then perform useful tasks such as sucking carbon out of the atmosphere. The replico-bots didn’t pan out, because—well, do I really need to explain? But the idea of capturing atmospheric carbon took root in Lackner’s head. The basic technology existed; submarines and the International Space Station had systems for scrubbing carbon from air, developed to keep their inhabitants from suffocating. Several years later, Lackner and some colleagues published a research paper on doing the same in the open air. They concluded that, at least from a technical perspective, "there are no fundamental obstacles."

Lackner moved on to Columbia University and took his idea with him. Concern over climate change was mounting, and polluters were coming under growing public pressure to scrub their smokestack emissions. Lackner was among the few calling for a different approach, one focused more on the end of the process than the beginning. "Roughly half of our emissions come from distributed sources," like cars, says Lackner, now a cheerily verbose, silver-haired professor at Arizona State University, where he runs the Center for Negative Carbon Emissions. Rather than chasing the long tail of emitters, "we need to figure out how to get rid of CO_2."

In 2004, backed by $5 million from the founder of Land's End, Lackner helped to launch Global Research Technologies, the first serious attempt to commercialize direct air capture. He and his colleagues spent several years building a small prototype, and burned through all their money in the process. The company withered away, but Lackner's faith did not. He has continued researching and talking up direct air capture ever since. The idea slowly spread to Europe, where Gebald and Wurzbacher learned about it as students.

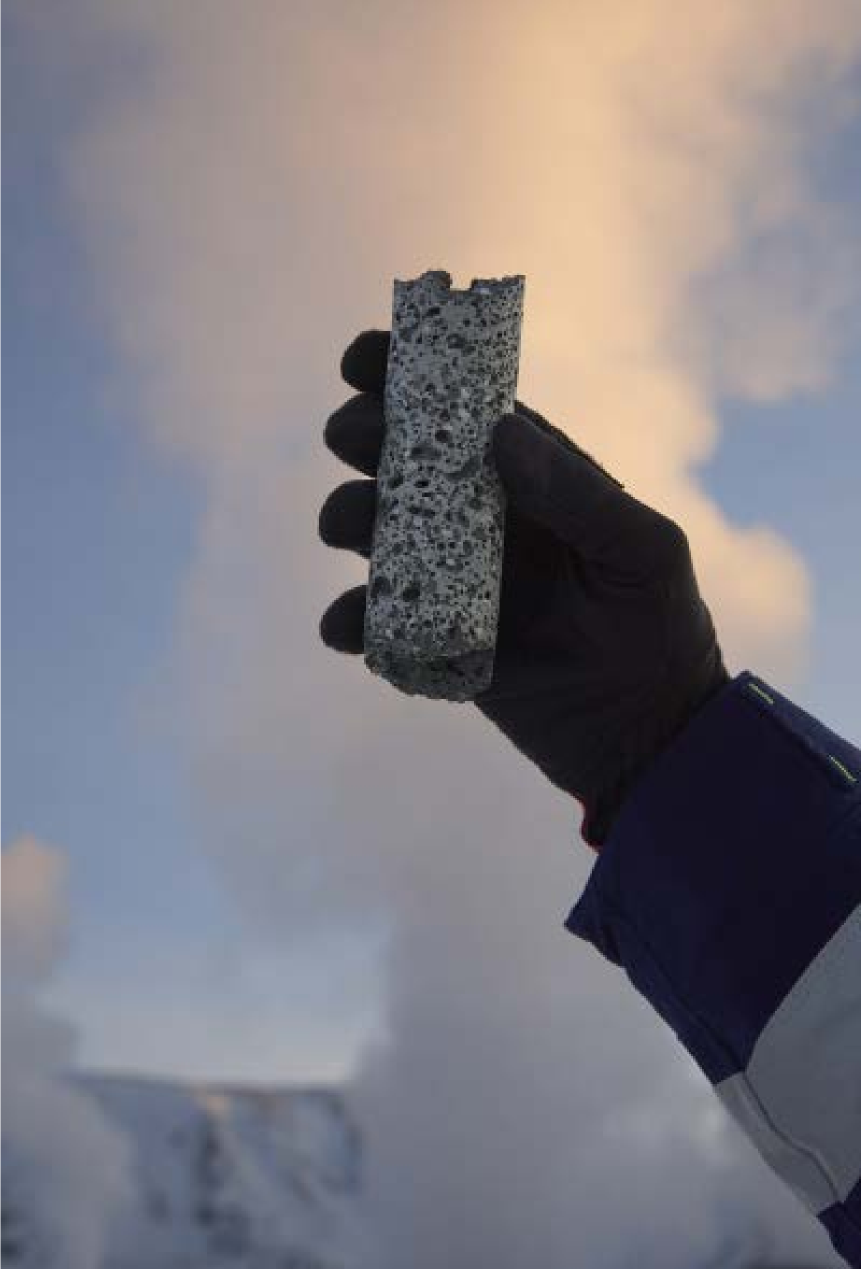
On the day after their big launch in Iceland, I'm sitting with the pair in a former fish factory in Reykjavik that is now a stylish startup space. Once again, the guys are dressed like twins, in collared shirts under neutral-colored sweaters. It doesn't end there. They were born three months apart, and so were their respective 3-year-old sons. Gebald, the (slightly) more emotive of the pair, oversees more of the marketing and sales these days, while the (slightly) more cerebral, detail-oriented Wurzbacher handles operations and finance. When they do butt heads, Wurzbacher estimates, the average dispute lasts 30 to 60 minutes.

The two met in October 2003, on their very first day as engineering undergrads at ETH Zurich, the Swiss Federal Institute of Technology. They were both outdoor-sports-loving, overconfident sons of engineers, drawn to the school as much by its proximity to Alpine ski slopes and mountain-biking trails as by its stellar academic reputation. At the orientation session for new students, they bonded over the difficulty they had understanding the Swiss dialect spoken by most other students. This is how they tell the story today: "What are you doing here?" Gebald asked his new acquaintance. "I came to study engineering. I want to have my own company someday," Wurzbacher replied. "Cool!" said Gebald. "I have the same dream! Let's do that!" They high-fived, and they have been working together ever since.

Casting about for an idea to turn into a suitably grand business, they ran across a professor, Aldo Steinfeld, who was (and still is) researching ways to manufacture synthetic fuels, which involved combining carbon dioxide with water and eventually producing a kerosene-like substance. Steinfeld had learned about Lackner's work, and he thought direct air capture might be a clean way to get the carbon dioxide he needed for his fuels. He encouraged Wurzbacher and Gebald to help him try to build a machine to make it work. They liked the idea of combating climate change. Among other things, as avid skiers, they were shocked by how much the glacier at one of their favorite Swiss resorts had retreated over the years. Plus, there was potentially a lot of money to be made.

Steinfeld took them on as graduate students. Wurzbacher and Gebald started by tinkering with the systems found in submarines, which use chemicals such as soda lime that lock onto CO_2 molecules. Among other challenges, they had to come up with a mechanical design that could be scaled up to handle *millions* of cubic meters of air. Their first prototype was barebones: a couple of hoses running air over a heap of filters coated with carbon-grabbing nitrogen-hydrogen amines—derivatives of ammonia—sitting in an aluminum bucket. It wasn't exactly world-changing. It took a full day to capture about half a gram of carbon dioxide. But it was a solid proof of concept. "We were proud, like we just landed on the moon," Gebald says. A Swiss foundation chipped in some $300,000, and Climeworks spun off from the university in 2009. "It was a really cool time," Gebald says. "We were skiing and dreaming. We were like, 'Yeah, we've got a company! Yeah, we're gonna solve it!'"

At almost the same time, David Keith, a Harvard professor and adviser to Bill Gates, was getting Carbon Engineering into gear in Canada. Another well-credentialed pair of experts was launching Global Thermostat in the US. Climeworks was the runt of the litter. "We were the young guys with zero track record, right out of uni," Gebald says. But the competition was helpful in a way; the fact that more-established scientists were pitching the same wild-sounding idea gave it more credibility. Richard Branson even offered a $25 million prize to companies that could commercialize ways to extract greenhouse gases from the atmo-



IN ICELAND AND ELSEWHERE, CAPTURED CARBON CAN BE INJECTED UNDERGROUND, TURNED INTO ROCK, AND STORED LONG-TERM.

sphere. Nobody wound up winning, but Climeworks made it to the finals.

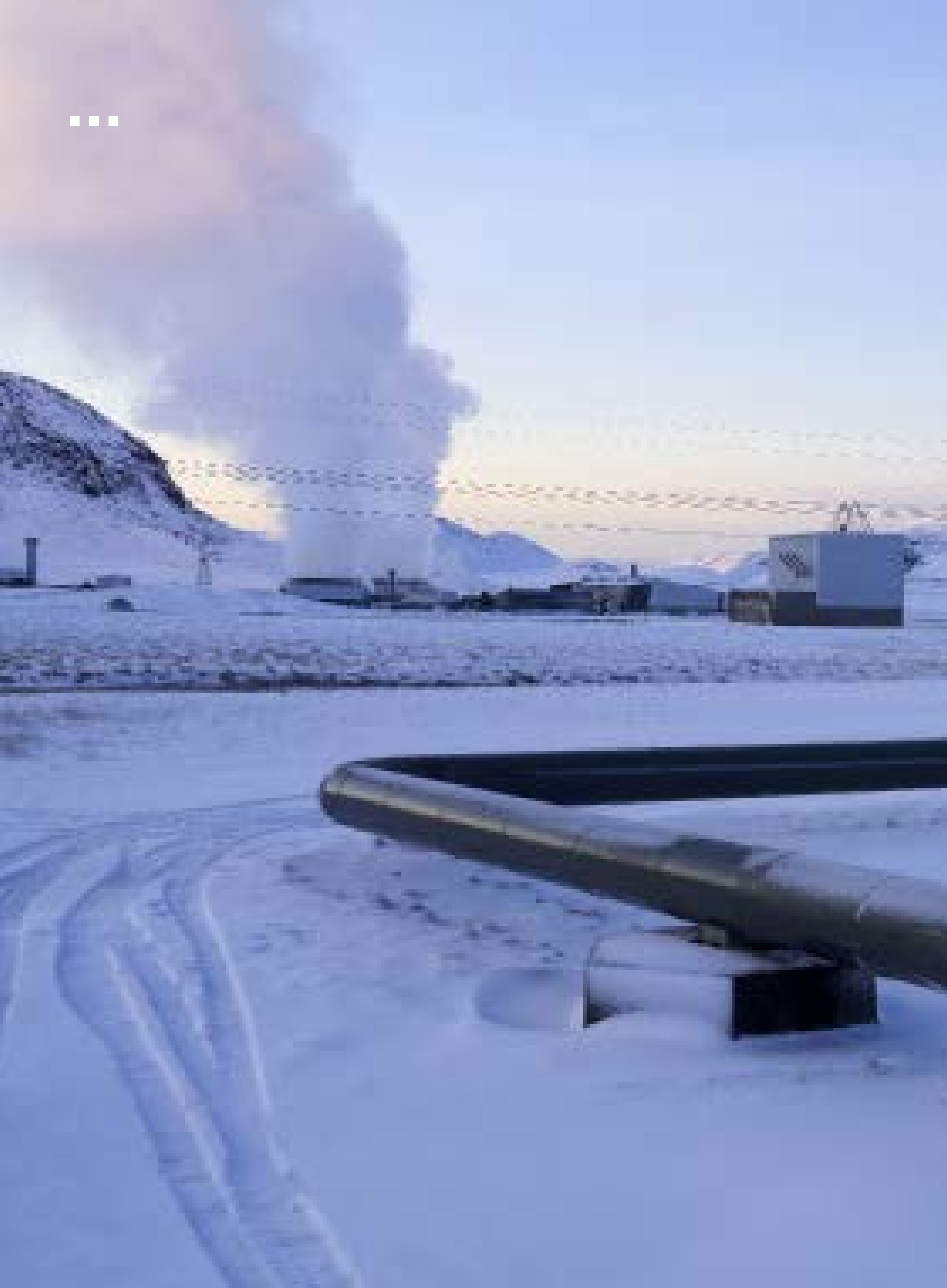
In 2011, however, the American Physical Society, a leading academic physics organization, released a report that basically concluded direct air capture was an expensive waste of time. “It was published in the local newspaper, and our investors were all wealthy people and they typically read it,” Gebald says. They managed to scare up around $2 million, but their investors had a condition: By the year’s end, they wanted to see a prototype capable of capturing a kilogram of CO_2 per day. Wurzbacher and Gebald scrambled to hack it together, trying out different setups and combinations of chemicals. By mid-December, they had a refrigerator-sized box stuffed with filters and a tube that pulled in air through the room’s window. They tested the machine, which seemed to operate as planned—but the readout showed it capturing barely 200 grams. The guys were flummoxed.

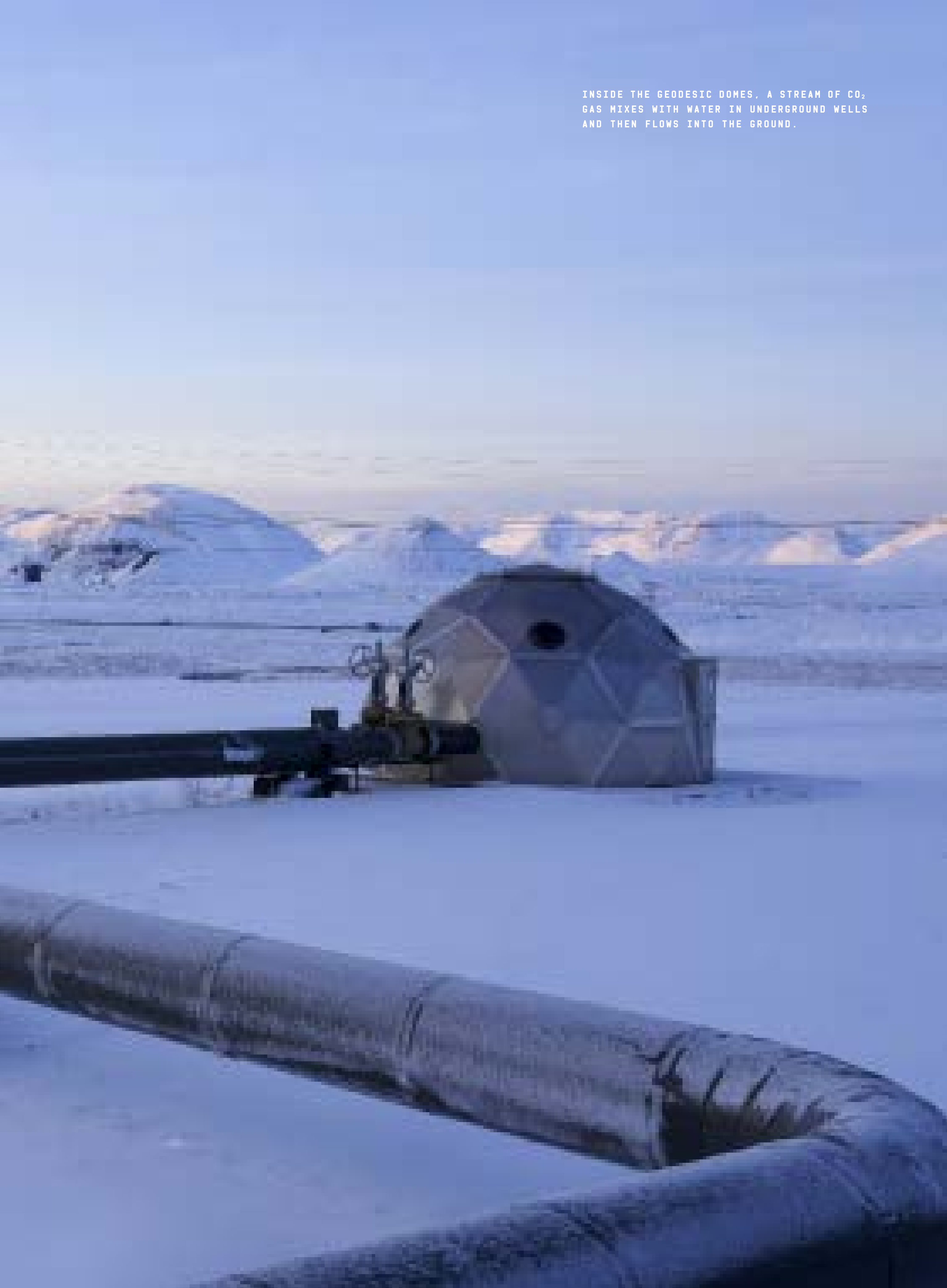
With the clock ticking down, they tried everything they could think of—double-checking the filters, rerunning parts of the process. Nothing helped. A few days before Christmas, Wurzbacher was staring forlornly at the machine, trying once again to figure out what was wrong. Then he heard a small, strange hissing sound; it was coming from one end of a tiny carbon-dioxide-carrying hose that had popped loose. It turned out the machine was in fact capturing several kilograms of CO_2—but the gas was leaking out just before it hit the sensor that would have recorded it.

Meanwhile, Climeworks’ competitors were also moving forward, each opening small demonstration facilities by the mid-2010s. Later in the decade, Climeworks retook the lead by opening its first real-world plant, just outside of Zurich. The team installed 18 silver-colored, barrel-sized fans and filters on the roof of a waste incineration facility. “I stood in front of many, many tons of steel and thought, ‘We actually built it!’ ” Wurzbacher says. Waste heat from the incinerator helps run the system, which pulls in some 900 tons of CO_2 per year from the atmosphere. Climeworks pipes the purified gas directly to a nearby greenhouse, where it helps the plants grow.

The rooftop machine is a small operation, but its launch marked the first time anyone had managed to use direct air capture to gather carbon and then sell it. It brought Climeworks plenty of admiring press, a visit from Greta Thunberg, and some $30 million in investment. With that plant, “we blew away the first layer of criticism” by proving that the technology works, Gebald says. But there aren’t enough incinerators to heat thousands of direct air capture machines, and greenhouses can’t absorb gigatons of carbon dioxide. To level their system up to the next order of magnitude, Wurzbacher and Gebald still had to contend with the questions of where the energy would come from and where the captured carbon would go. Which brings us to Iceland—by way of Morocco.

ONE EVENING IN NOVEMBER 2016, GEBALD WAS AT a swanky party in Marrakesh thrown by the philanthropist Laurene Powell Jobs. He was feeling a little





INSIDE THE GEODESIC DOMES, A STREAM OF CO_2 GAS MIXES WITH WATER IN UNDERGROUND WELLS AND THEN FLOWS INTO THE GROUND.

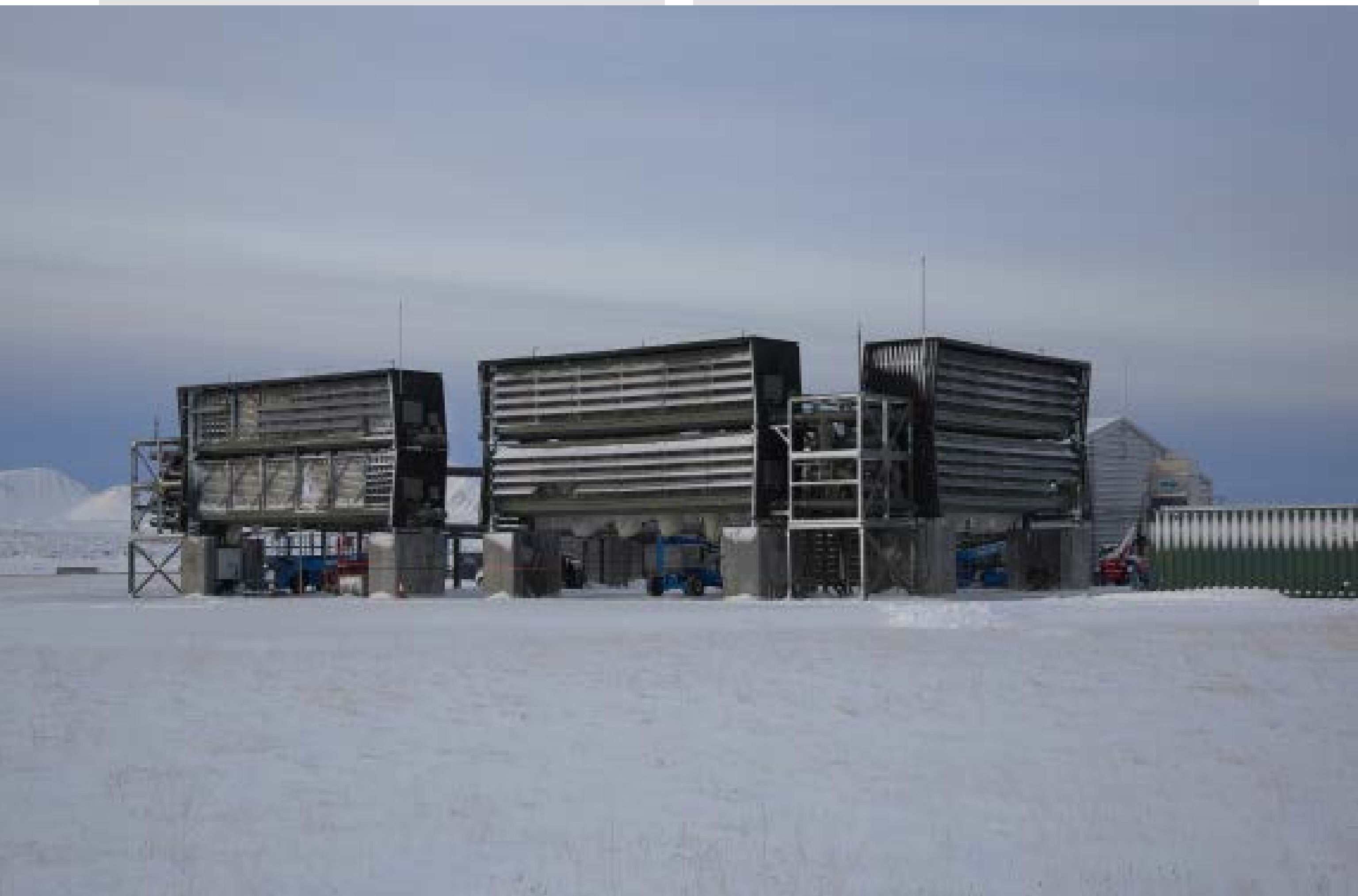
out of place among her guests, a gaggle of prominent climate researchers, activists, and policymakers who were in town for the COP conference, a major annual event in climate circles. Dutifully making the rounds, he met a gregarious man with richly coiffed white hair. It was Ólafur Ragnar Grímsson, the recently retired president of Iceland. Gebald gave him the spiel about Climeworks. "That's fantastic!" Gebald recalls Grímsson saying. "I can store CO_2 underground in my country. But we've been lacking the technology to capture it."

Grímsson was talking about Carbfix, a subsidiary of publicly owned Reykjavik Energy, which was developing a system to sequester carbon by injecting it into underground geologic formations. Reykjavik Energy also happens to operate a couple of nice, clean geothermal power plants. Grímsson made some introductions, and soon after, Gebald and Wurzbacher were hammering out a partnership with Carbfix.

Icelandic officials may have been welcoming, but Iceland itself was less so. Wurzbacher and Gebald built a small experimental plant with a single intake fan near Hellisheidi in 2017, but in short order "it literally froze," Gebald says. One day when the temperature dropped below zero, steam from the geothermal plant hit the machine's bare metal, covering it in ice. Another time, a giant storm almost carried away the whole multiton structure. "We had to bolt it to the ground," Gebald says.

Four years and many hitches later, Climeworks' new plant, dubbed Orca (after both killer whales and the Icelandic word for "energy"), came online. It sits in the verdant volcanic plain, a short drive from the visitors' center where the opening ceremony was held. Eight olive-green steel boxes the size of shipping containers

GIANT BANKS OF AIR-CLEANING FANS PERCH ON CONCRETE PILLARS ON A VOLCANIC PLAIN, WHERE GEOTHERMAL ENERGY IS ABUNDANT.



IT COSTS CLIMEWORKS AROUND $750 TO CAPTURE A SINGLE TON OF CARBON.

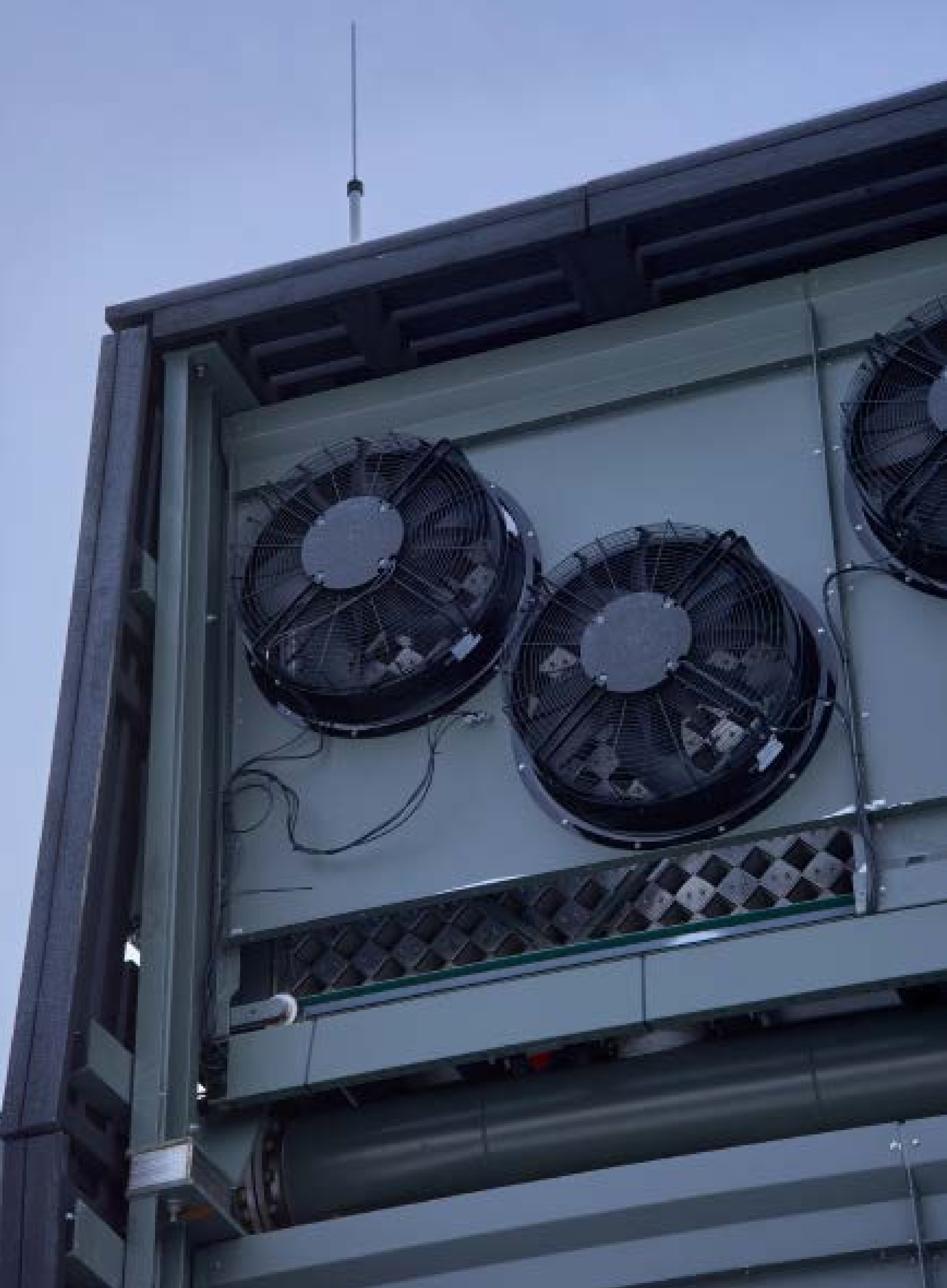
stand on concrete risers, connected by elevated pipes to a low white building that is the control center. The steel vessels, dubbed CO_2 collectors, are fronted by large black fans that pull in rivers of air.

Inside the collector boxes, the air runs over filters coated with amine-based sorbents and other materials that grab hold of the CO_2 molecules. The carbon eventually saturates the filters, like water bloating a sponge. At that point, sliding gates seal off the air intake, and hot air is piped in from the control center to heat the filters to around 100 degrees Celsius, which releases the CO_2. Vacuums then pull the free-floating molecules to the control center, where gleaming tanks, ducts, and other hardware compress the gas. It's then piped over to a handful of igloo-sized geodesic steel domes a couple miles away, squatting on the plain like emergency housing for Martians.

Carbfix technicians and machines handle the next steps. Inside the domes, a powerful motor pushes an incoming stream of water down into an injection well. The CO_2 pipeline dumps the gas into the water. "It's an underground SodaStream!" says Sandra Snæbjörnsdóttir, a Carbfix scientist with shoulder-length brown hair and earnest green eyes framed by tortoise-shell glasses who helped design the system. A few hundred meters down, the soda stream flows into the ground, where it reacts with basalt deposits that turn it into a solid mineral. In other words, the climate-warming carbon gas is turned into stone, like the villain in a fairy tale. "It's essentially nature's way of storing CO_2," says Snæbjörnsdóttir. There's plenty of room for this tactic. Worldwide, there are probably enough suitable geologic formations to store trillions of tons of carbon.

On the most basic level, the system does what it's supposed to: Climeworks extracts carbon from the air, and Carbfix buries it underground. And they both use geothermal power, which produces only minor greenhouse emissions. But the capturing part is still tremendously energy intensive, and therefore expensive. The fans need electricity, of course, but the bulk of the power goes to heating up the carbon to liberate it from the sorbent.

Jennifer Wilcox, a veteran carbon researcher and principal deputy assistant secretary at the US Department of Energy, has estimated that to grab a million tons of carbon, a direct air capture plant could devour on the order of 300 to 500 megawatts of energy per year—enough to power some 30,000 American homes. (And remember, that power has to be clean; otherwise



CLIMEWORKS' PLANT SUCKS IN ABOUT 4,000 TONS OF CARBON A YEAR AND IS THE LARGEST DIRECT AIR CAPTURE OUTFIT IN THE WORLD.

you're generating at least as much carbon as you're capturing.) Wurzbacher reckons that's in the right ballpark. Climeworks engineers estimate it costs around $750 to capture a single ton of carbon. Independent estimates of various direct air capture approaches reach as high as $1,000 per ton. If the industry were to grow significantly, those costs would almost certainly fall. Components such as the collector boxes would become cheaper and easier to make, and the energy efficiency could improve. Climeworks and Carbon Engineering, along with several outside experts, believe they can get down to $100 a ton.

But even if that bears out, multiply $100 by even a single gigaton—barely enough to make a dent in our annual emissions—and you're talking about $100 billion. (The National Academy of Sciences has estimated that by 2050 we need to be removing at least *10* gigatons of carbon. Every year.) That's on top of the hundreds of billions of dollars that would be required to build the plants themselves.

Wurzbacher and Gebald aren't expecting to cover those costs by selling carbon to greenhouses. Nor by using it for synthetic fuels, which is still one of their sidelines. The big money, they figure, lies in selling carbon sequestration to the hundreds of corporations, cities, and other entities that have pledged to reduce their emissions. Insurance giant Swiss Re, Microsoft, Stripe, the Economist Group, and Audi (not to mention Coldplay) have already signed up to pay Climeworks millions of dollars to bury carbon for them.

Meanwhile, on the other side of the world, Climeworks' principal rival is racing to build a facility that will also enable a giant corporation to bury carbon—but for quite a different purpose.

5

STEVE OLDHAM, A MIDDLE-AGED BRIT FROM Manchester, is CEO of that rival company, Carbon Engineering. I visited him last summer at the company's headquarters in the almost unbearably scenic town of Squamish, British Columbia. It sits between majestic, waterfall-lined mountains and a fjord-like inlet of the Pacific Ocean. I arrived on a warm morning, in the run-up to an epochal heat wave. Three days after my visit, the town of Lytton, a couple of hours away, was hit with the highest temperature ever recorded in Canada. The next day was even hotter, and the next hotter again. The day after that, Lytton caught fire and burned to the ground. Hello, climate change.

We sat in Oldham's office in a trailer on Carbon Engineering's site, windows looking out on the mountains. He wore a cornflower-blue short-sleeved button-up and gray slacks. A software engineer by training, he came to Carbon Engineering in 2018 from a Canadian space-tech company. That same year, the IPCC report endorsing direct air capture came out, and founder David Keith published a research paper mapping out how, given certain design choices and energy prices, Carbon Engineering's capture costs could be brought down as low as $94 a ton. (Keith is still on the company's board but isn't involved in day-to-day operations.) Since then, the company has been on a roll. Carbon Engineering has raised $160 million. In the past three years, its staff has nearly quadrupled, to a total of 146.

The demonstration plant set up in 2015 is still there, a cobbled-together collection of machines inside a beat-up, corrugated-metal building inherited from the chemical company that used to occupy the site. Powered by natural gas, the machine sucked in about a ton of carbon per day. When I visited, a construction crew was working on a bigger facility that is expected to come fully online in 2022.

Oldham and I put on hard hats, steel-toed boots, and garish hi-viz vests to tour the place, at times shouting over the roar of diesel-powered construction machinery and clanging hammers, the acetic smell of welding drifting through the air. We clambered up three stories of steel stairs to the top of an air intake tower crowned with a giant fan. From there we looked down on the hodgepodge of tanks, walkways, ladders, and ducts, freshly painted in bright blues and yellows and the company's signature shade of fuchsia. The plant, which will capture only about 1,000 tons of carbon per year, will serve as an experimental lab for much larger facilities coming soon. First up: a 1 million-ton-per-year plant that's slated to break ground in Texas in 2022. Systems in Scotland and Norway are in the design phases and will capture 500,000 to 1 million tons per year.

Carbon Engineering's tech works on the same basic principles as Climeworks', but the two companies have very different business models. That million-ton plant in Texas is a partnership with a subsidiary of Occidental

Petroleum, a major oil and gas company based in Houston. Oxy, as it's commonly known, plans to inject the captured carbon into the ground to push more oil into its wells, a process known as enhanced oil recovery. The CO_2 will stay underground—but putting it there will drive more fossil fuels into the maw of the American economy, which will belch them back out as greenhouse gases. In other words, the plant will capture carbon and use it to help put more carbon into the air.

Back in Oldham's office after our tour, I ask him: Doesn't that seem counterproductive? "We get this criticism a lot," he tells me, leaning back in his chair.

"I'm a pragmatist," he says. "We have to solve this problem, we have to get climate change figured out." It "makes a lot of sense," he adds, to get the energy sector involved. Chevron has also invested in Carbon Engineering, and ExxonMobil has a partnership with Global Thermostat. Fossil fuel executives are among the rare people willing to pay for the machines and the CO_2 they capture, no doubt because it helps them extract more oil while scoring public-relations points. What's more, those companies are already set up to wrangle large amounts of carbon dioxide—they've got pipelines to shuttle it around, knowledge of where favorable geological formations are, and experience with putting the stuff into the ground.

Oldham says the Texas plant's energy will come mainly from dedicated solar or wind plants. The net result is "carbon-free fossil fuel," he says. "We're pulling as much CO_2 out of the air as is contained in the crude that comes up." He doesn't expect to stick with enhanced oil recovery forever. Like Climeworks, Carbon Engineering is also trying to spin captured carbon into synthetic fuel. But in the meantime, Oldham needs customers, and the world still runs on oil. "If we can make fossil fuel carbon-free," he asks, "why is that a bad thing?"

FOR DIRECT AIR CAPTURE TO HAVE A REAL IMPACT, THE INDUSTRY WILL HAVE TO EXPAND AT A STUPEFYING RATE.

I

IT'S A LOGICALLY SOUND ARGUMENT. BUT IT'S shoulder-shrugging logic. It could be a bit like funding a drug rehab clinic by renting space to a pill mill. Climeworks has staked out a different position: The company won't get involved with enhanced oil recovery, period. "We want to change something substantially with how we fight climate change," Wurzbacher says; to him, working with oil companies is not substantial enough.

Unimpressed by this distinction, many environmentalists condemn the whole field of direct air capture. They argue that it undercuts efforts to shrink greenhouse gas emissions by dangling the illusion that we can keep burning fossil fuels and simply vacuum up their CO_2. In July, more than 500 groups signed an open letter to American and Canadian political leaders declaring carbon capture "a dangerous distraction."

Everyone I spoke to in the direct air capture industry says that they, too, believe the world needs to cut CO_2 emissions as deeply as possible. But that will take time, and by now, there's already so much CO_2 in the air that even if we magically quit burning all fossil fuels tomorrow, the planet would continue to feel the effects of climate change. What's more, renewables won't solve all our emissions problems anytime soon: Large airplanes can't yet run on electric batteries, and cement production generates CO_2 as a byproduct, for instance. "We're at a stage where avoiding carbon is no longer enough," says Wilcox, the Energy Department official. "We're going to have to be taking it back out of the atmosphere."

There are other ways we might do that—we might plant billions of trees or spread out tons of minerals, such as olivine, that bind to carbon in the air. Those strategies have significant costs and risks of their own, of course. Among other things, trees can burn and re-release all their carbon, and mining and crushing minerals eats up a lot of energy. No single method is potent enough to capture the 10 gigatons of carbon dioxide per year the National Academy of Sciences prescribes. We'll need to deploy several. But which ones?

For direct air capture to have a real impact, the industry has to find a way to expand at a stupefying rate. Climeworks, Carbon Engineering, and their ilk need to build *thousands* of plants to capture even a few gigatons of carbon dioxide. That's not impossible, but it is a very tall order. Most countries don't penalize dumping carbon into the atmosphere, so business leaders have little incentive, beyond the goodness of their hearts, to spend billions to clean up their emissions.

Klaus Lackner, the direct air capture pioneer, thinks we should treat carbon emissions the way we do sewage or municipal garbage: as a waste product to be cleaned up, perhaps with taxpayer funds. Support of that sort is starting to emerge. Canada is one of Carbon Engineering's investors, and the European Union is backing Climeworks. The United Kingdom has pledged up to about $125 million for direct air capture research. Until recently, the US provided only piddling support, but in August the Department of Energy doled out $24 million in research grants, and the Biden administration's infrastructure law allocates $3.5 billion for the construction of four 1 million-ton direct air capture "hubs" around the country.

Government incentives can also push polluters to clean up their atmospheric mess. American companies are eligible for a federal tax credit of up to $50 for every ton of carbon they sequester, an amount Congress may soon boost; California offers additional credits. That's helpful, but it still doesn't come near to covering the current costs of paying a direct air capture company to do that sequestering.

At the end of the day, direct air capture may turn out to be impractical or unsustainable or less effective than other tactics for removing carbon from the atmosphere. We need to find out, and quickly. If the real-world results from facilities such as Orca show the tech can take a serious bite out of atmospheric CO_2 at a cost somewhere below insane, we should pour money into getting more built, ASAP. If they don't, we should pour money into planting trees or spreading minerals or whatever other techniques work better. (Need I add that we should also be moving full-speed from fossil fuels to renewables?)

All of which would require tremendous public investment in technologies that might not pay off. It's worth remembering that we make gambles like that all the time. In the past year and a half, for instance, the United States has invested billions into developing Covid vaccines, many of which didn't pan out.

We make those kinds of investments when we believe the well-being of the entire nation is in danger. We don't wait around for a market to develop when we're confronted with a crisis that imperils millions of lives. We pulled out all the stops to fight an airborne virus; we need to do the same to fight an even worse threat that's also carried in the air.

VINCE BEISER *(@vincebeiser) lives in Vancouver, Canada. He wrote about a biofuel scam in issue 29.03.*