RESEARCH & PERSPECTIVES

The thinking behind the thesis

Direct Air Capture: Pathways to a Bankable Cost Curve

Where Modular DAC Has to Reach on Energy and Cost per Tonne to Unlock Durable Offtake and Project Finance

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The Investment Thesis of the Family Office

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Abstract

The earlier papers in this series argued that captured carbon is a feedstock and that green methanol is the product that gives the feedstock its value. Both depend on captured CO_2 being available at a price that supports project economics, and today the most expensive source of that carbon is direct air capture (DAC). This paper examines what DAC has to achieve on energy and cost per tonne to become bankable, and it reaches a specific conclusion about where our family office invests. We do not back DAC developers directly. The cost curve, the scale-up risk, and the technology-winner uncertainty make first-of-a-kind capture plants a poor fit for patient capital. Instead we invest in the equipment companies that supply the essential secondary technology every DAC project needs regardless of capture chemistry: compression, CO_2 purification, gas handling, heat integration, and system integration. This is a picks-and-shovels position. In 2026 removal costs sit in a wide band of roughly US$400 to US$1,000 per tonne, well above the US$100 per tonne that policymakers regard as the threshold for climate-scale viability, and the technology consumes on the order of 1.5 to 2.5 megawatt-hours of energy per tonne captured. Three levers determine whether DAC descends its cost curve: cheap zero-carbon energy, modular manufacturing that compounds learning, and durable offtake that makes projects financeable. Whichever capture technology and whichever developer prevail, all of them depend on the same downstream equipment, which is why supplying that equipment captures the sector's growth while avoiding its single-project and single-technology risk. We conclude that the attractive position is upstream of the cost-curve fight, as a supplier of enabling systems, with a preference for projects that couple DAC to utilization rather than storage alone. This connects the cost-of-carbon question back to the feedstock thesis and forward to the demand case for sustainable aviation fuel.

Keywords: *direct air capture; cost per tonne; carbon removal; modular manufacturing; offtake agreements; project finance; learning curve*

1. Introduction: The Price of Carbon from Thin Air

Direct air capture pulls CO_2 directly from the atmosphere rather than from a concentrated industrial flue gas. That gives it a unique property: it can supply carbon anywhere, decoupled from any emitting facility, and it can deliver genuine removal rather than merely avoided emissions. It also gives it a unique problem: extracting a molecule that makes up roughly four hundredths of one percent of ambient air is intrinsically energy-hungry and therefore expensive. The question is not whether DAC works, because it does, but whether it can descend a cost curve steep enough to become an investable infrastructure class.

This paper treats that cost curve as the central issue, because it is the variable that governs everything downstream in our investment thesis. The companion papers held that captured carbon is worth more as a feedstock than as a liability, and that green methanol is where the feedstock becomes a saleable product. Both arguments assume the carbon can be sourced at a workable price. Point-source capture supplies that carbon cheaply today, but the long-run, location-flexible source is DAC, and DAC will only underpin a durable feedstock supply if its cost falls far enough to clear project-finance hurdles.

We set out where DAC stands on cost and energy in 2026, identify the three levers that move it down its curve, and describe the change in the offtake market that is beginning to make DAC projects financeable. From that analysis we draw a conclusion about position rather than about the technology: that the way to gain exposure to DAC's growth without carrying its cost-curve and technology-winner risk is to supply the enabling equipment every project needs, not to build the plants. We close with what this means for where patient capital should sit.

2. Where the Cost Curve Sits Today

DAC in 2026 is roughly where solar photovoltaics sat in the early 2000s: proven, small in scale, dependent on subsidy, and expensive, but potentially on a learning curve that could drive costs down sharply if manufacturing scale and iteration materialise. The comparison is instructive both for its optimism and for its caution, because solar took four decades to fall roughly 99% in cost.

Current economics remain difficult. Removal costs in 2026 span a wide band of roughly US$400 to US$1,000 per tonne, with the market leader's credits selling in the US$600 to US$1,000 range and newer entrants signing agreements below US$200. Against this, the U.S. Department of Energy's viability threshold is about US$100 per tonne, and Climeworks itself targets US$250 to US$350 per tonne by 2030 on its way toward the US$100 level by 2050. Energy is the dominant cost: DAC generally consumes on the order of 1.5 to 2.5 megawatt-hours per tonne of CO_2, a thermodynamic penalty that pulling dilute carbon from ambient air can reduce but never eliminate. Real-world output has also lagged design capacity in early plants, underscoring that the gap between where DAC is and where it must be is not one the current trajectory closes on its own.

Table 1

Indicative DAC Cost and Energy Benchmarks (2026)

Metric	2026 Position	Threshold / Target
Removal cost	US$400–1,000/t	~US$100/t (DOE viability)
Leading-player credit price	US$600–1,000/t	US$250–350/t by 2030 (Climeworks)
Frontier offtake price	Under US$200/t (e.g. CO280)	Sub-US$108/t targeted (Heirloom)
Energy intensity	1.5–2.5 MWh/t	Lower via heat recovery, electrochemical
Downstream transport/storage	Adds US$50–150/t	Location-dependent

Note. Figures are indicative 2026 estimates compiled from public offtake disclosures and sector analysis; they exclude and, where noted, add downstream transport and storage. Prices vary by technology, energy source, and contract structure.

3. The Three Levers That Move the Curve

Whether DAC descends its cost curve depends on three levers acting together. None is sufficient alone, and the second and third are where a technology-agnostic investor can participate without betting on a single capture chemistry.

3.1 Cheap Zero-Carbon Energy

Because energy is the largest operating cost, the single most important determinant of a project's economics is the price of the power and heat it consumes. This is why DAC deployment is clustering in regions that offer abundant low-cost, zero-carbon energy: geothermal in Iceland, solar in the U.S. Southwest and the Middle East, and, most relevant to this series, China's desert solar bases, where electricity can fall below the equivalent of a few US cents per kilowatt-hour. Solid-sorbent systems that regenerate at modest temperatures of about 80 to 120 degrees Celsius further widen the options, because they can draw on low-grade industrial waste heat rather than costly high-temperature heat. A project's energy profile, more than its capture chemistry, is the most critical factor in attracting investment.

3.2 Modular Manufacturing and the Learning Curve

The credible path to lower cost is factory-style manufacturing of standardised, container-scale units, rather than bespoke megaprojects. Modular designs, such as collector arrays built from dozens of identical container units, allow each production cycle to compound the learning that drove down solar and battery costs. Experience from those industries suggests the potential for

15% to 25% annual cost reductions during scale-up, provided volume actually materialises. This is the lever that most favours manufacturing economies, and it is where China's container-based production capability and its verified modular units are strategically significant. The bet is not on any one sorbent but on whether modular manufacturing enables the same cost learning that scaled earlier clean-energy technologies.

3.3 Durable Offtake and Project Finance

A capital-intensive first-of-a-kind plant cannot be financed on spot sales. It needs contracted, multi-year revenue, and this is where the market shifted most decisively in 2025 and 2026. Creditworthy buyers, including major banks, airlines, and technology and industrial firms, have signed binding ten-year removal agreements, and corporate demand for removal credits has reached the low millions of tonnes. These contracts do for DAC what power-purchase agreements did for wind and solar: they convert future removal into a present, bankable asset and unlock the project finance that construction requires. Developers increasingly aim to have plant capacity substantially pre-sold before the final investment decision, exactly the model that de-risked renewables. Taken together, these three levers show how much has to go right inside the capture plant for a DAC developer to succeed, which is the reason we prefer to stand beside the developers rather than among them, a point the next section develops.

4. The Position: Enabling Equipment, Not Capture Plants

The analysis so far points to an uncomfortable fact for a would-be DAC investor: the cost curve, the scale-up risk, and the uncertainty over which capture chemistry prevails all sit inside the capture plant itself. Backing a single developer means underwriting a first-of-a-kind facility whose economics depend on energy prices, manufacturing learning that may or may not arrive, and offtake that may or may not be secured. That is a concentrated bet on both a technology and a project. For patient capital seeking durable returns, it is the wrong place to stand.

There is a better position, and it is upstream of the capture-technology contest. Every DAC project, whatever its sorbent or solvent and whoever builds it, depends on the same enabling systems: the captured CO_2 must be purified to pipeline or synthesis grade, dried, compressed to high pressure, and integrated with heat and power. These are mature, well-understood engineering functions, and they are common to solid-sorbent, liquid-solvent, and electrochemical approaches alike. Supplying that equipment captures the sector's growth while sidestepping its single-project and single-technology risk. It is the picks-and-shovels position: one does not have to pick the winning miner to profit from the mining boom, provided one sells the tools every miner needs.

Table 2

Enabling Equipment Common to All DAC Pathways

Function	Why Every Project Needs It	Technology-Agnostic?
CO_2 purification	Raw capture output must reach >99.5% (pipeline) to >99.9% (synthesis)	Yes
Compression	CO_2 must be compressed to ~100–150 bar for transport or reaction	Yes
Gas handling / drying	Impurities and water must be removed to prevent corrosion	Yes
Heat integration	Regeneration heat must be sourced and managed efficiently	Yes
System integration	Capture, conditioning, and utilization must be packaged together	Yes

Note. These functions are required by every capture chemistry and by both storage- and utilization-bound projects. They are the family office's point of entry, independent of which developer or sorbent prevails.

Most DAC offtake today is sold as carbon-removal credits, with the CO_2 stored permanently underground. That is a legitimate and, for durability, valuable model, but it leaves the project dependent on the price and policy durability of removal credits. The papers preceding this one argued for a different disposition: using captured carbon as a feedstock for green methanol and, downstream, sustainable aviation fuel. That utilization route matters to the equipment supplier as well, because it demands even more of the purification and conditioning capability we favour: synthesis-grade CO_2 must reach higher purity than pipeline transport requires. The most attractive projects for our purposes therefore couple low-cost DAC to a utilization offtake, and the equipment that enables that coupling is precisely where we invest.

5. What This Means for Where We Invest

If the attractive position is upstream of the capture-technology contest, then the investment logic is to back the equipment companies that supply DAC developers rather than the developers themselves. This gains exposure to the sector's growth while avoiding the concentrated risk of any single plant or capture chemistry. The principles that follow guide where we deploy:

- **We supply the tools, we do not pick the miner.** We invest in equipment companies providing the compression, purification, gas-handling, and integration systems that every DAC project requires, rather than in DAC developers whose success depends on winning a single-technology, single-project bet.
- **We stay technology-agnostic.** Because these enabling systems are common to solid-sorbent, liquid-solvent, and electrochemical approaches, our returns do not depend on which

capture chemistry prevails, which removes the hardest judgement in the sector from our underwriting.

- **We favour suppliers positioned where deployment clusters.** Because DAC concentrates where zero-carbon energy is cheapest, we favour equipment companies with manufacturing scale and relationships in those regions, China foremost, whose container-based production and cost learning can serve the build-out.
- **We prefer suppliers exposed to utilization, not only storage.** We weight equipment providers whose purification and conditioning capability serves synthesis-grade CO_2 for green-methanol and fuel production, broadening their addressable market beyond storage-bound projects and tying them to the feedstock thesis of the earlier papers.

The through-line is consistent with the rest of the series. DAC is the long-run, location-flexible source of the carbon feedstock the earlier papers identified, but its cost curve, scale-up risk, and technology uncertainty make the capture plants themselves a poor home for patient capital. The durable position is to supply the enabling equipment that every project needs regardless of who wins, with a preference for suppliers tied to utilization. The final paper turns to the demand that ultimately pulls this whole chain into being: sustainable aviation fuel and the methanol-to-jet opportunity that gives captured carbon its highest-value home.

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