Ara Built to Decarbonize.®

Building Resilient, Low Carbon Fertilizer Infrastructure

Turning agricultural waste into high-value nitrogen fertilizer

Introduction

“Unlocking substantial untapped investment potential in nutrient recovery and low-carbon fertilizers across the agricultural value chain.”

Conventional and organic agriculture, historically, both faced difficult tradeoffs when it came to fertilizer supply, but this is changing. Conventional crop nutrition has depended on centralized, fossil fuel-intensive production of ammonia and other nitrogen products. This model has delivered a step-change in yields, but it has also locked in large greenhouse gas emissions, exposure to volatile natural gas and commodity prices, and supply chains vulnerable to geopolitical shocks. The closure of the Strait of Hormuz underscored how concentrated and fragile fertilizer supply chains can be. Organic agriculture has depended on organic materials, such as bulky manures, that have low nutrient-density and are often limited to local sources due to high transportation costs - forces that together generate lower yields per acre and drive up the cost of sustainable produce. In this thought leadership piece, we describe the forces reshaping the fertilizer landscape, how nutrient recovery is evolving into a distinct, investable infrastructure theme, and why Sedron Technologies’ Varcor platform represents a scalable way to decarbonize one of the most fundamental inputs in the global food system. At the heart of that platform is a simple, appealing story for investors: dairy waste in, decarbonized organic fertilizer out.

From commodity input to strategic decarbonization lever

“Conventional fertilizers are essential for farming but are emissions-intensive and ripe for reinvention.”

Synthetic fertilizers, and nitrogen in particular, sit at the heart of modern agriculture. Ammonia and its derivatives are indispensable for achieving the yields required to feed a growing population. Yet conventional ammonia production is one of the most emissions-intensive industrial processes in the world, built around large, fossil fuel-fired plants that are typically located far from farm regions and face input costs coupled to natural gas markets. The result is a supply chain that is carbon-heavy, geographically concentrated, and periodically stressed by energy price spikes and geopolitical events.

In parallel, many large-scale agricultural systems, such as livestock herds, generate meaningful but diluted nitrogen-bearing streams that must be carefully managed to avoid waterway pollution and other regulated environmental issues. Historically, these streams have been viewed almost exclusively through the lens of cost and risk: the goal has been to treat or dispose of them at the lowest possible price while meeting regulatory requirements, with little attention paid to recovering embedded nutrient value.

That picture is beginning to change. Food brands, retailers, and investors are tightening expectations around sustainability and Scope 3 emissions, and fertilizer is emerging as one of the most powerful levers for reducing the embedded carbon in agricultural supply chains. Growers and ag retailers are looking for more resilient and regionally anchored nutrient options that do not leave them fully exposed to global commodity cycles. Regulators and customers are putting greater emphasis on nutrient stewardship, and customers are placing greater emphasis on sustainability in the goods they purchase. Together, these forces are pushing the market away from a narrow focus on cost and volume toward a broader set of buying criteria that includes carbon intensity, traceability, and supply resilience. Within this context, turning underutilized nitrogen streams into circular, low-carbon fertilizers is becoming a strategic opportunity.

Market size and growth drivers

“Volume growth, tightening sustainability expectations, and supply-chain volatility are driving innovation in fertilizers.”

$100+ b/yr

flow through the global fertilizer market[1]

The global fertilizer market is measured in over a hundred billion dollars per year, with nitrogen products representing a large share of that value.[1] Beneath these headline figures lies a more focused, emerging segment: nutrient recovery and low-carbon fertilizer platforms that target industrial and agricultural feedstocks with meaningful nitrogen content and sufficient volume to support infrastructure-scale projects.

Several structural drivers support continued growth in this segment. Population and income growth continue to drive steady demand for crop nutrients, a trend that is largely independent of short-term macroeconomic cycles. At the same time, supply-side volatility has highlighted the risks of overreliance on centralized, fossil fuel-linked production, increasing the appeal of regionally diversified and more stable fertilizer sources. A growing number of downstream food and beverage companies, retailers, and institutional investors now have explicit emissions reduction targets that reach deep into their agricultural supply chains, creating demand for inputs with verifiable, lower-carbon attributes. Finally, regulatory attention to nutrient losses, water quality, and industrial emissions is sharpening the need for solutions that treat nitrogen not just as waste, but as a resource. The combination of these drivers points toward a market capable of supporting hundreds of advanced nutrient-recovery facilities globally, each tied to local agricultural demand and industrial feedstocks.

[1] Ara Estimates

A shift toward circular nutrient systems

“A new level of resource recovery from nitrogen-rich streams.”

The emerging model in fertilizer supply treats nitrogen-laden waste streams less as a liability and more as feedstock. Instead of designing systems solely to stay below discharge limits at the lowest operating cost, operators and investors are increasingly exploring approaches that concentrate and upgrade nitrogen into commercially valuable fertilizer products. In broad terms, many agricultural streams can be processed into distinct, monetizable outputs: reusable water that can offset local industrial or non-potable demand, and concentrated nitrogen products that can be sold into conventional or organic fertilizer channels or used in specialized climate-smart agriculture programs.

In addition to the direct economic value of recovered products, these circular systems serve a risk-management function for companies facing mounting pressure on emissions and nutrient stewardship. Rather than pushing nitrogen downstream in dilute form, advanced treatment and separation allow operators to concentrate and control nitrogen in ways that are easier to monitor, verify, and tie back to specific decarbonization and stewardship goals. This capability is particularly relevant for food brands and retailers that are looking for traceable, lower-carbon inputs and need to demonstrate credible progress against their climate commitments.

A new infrastructure-style revenue model

“Fertilizer supply is becoming a generational, infrastructure-like investment opportunity."

What makes this shift particularly compelling from an investment perspective is not only the technology, but also the infrastructure-style business model emerging around it. Rather than selling equipment outright to industrial operators or agricultural suppliers, a new class of project developers finances, builds, owns, and operates nutrient-recovery facilities. Industrial counterparties contract for treatment or processing services, paying a fee per unit of liquid handled, while growers and distributors purchase the resulting fertilizer products under long-term agreements. This structure allows feedstock providers to avoid large upfront capital expenditures and operational complexity, while securing compliant, predictable management of their nitrogen-rich streams. At the same time, it gives fertilizer buyers access to a new class of traceable, lower-carbon nutrients without taking on technology or project development risk.

Revenues for these projects rest on two primary pillars. On one side are processing or service fees paid by the feedstock generators under multi-year contracts, underpinned by the essential nature of their waste-management needs and the limited number of high-quality alternatives. On the other side are sales of recovered fertilizer products into diversified agricultural markets, often supported by buyers who value both agronomic performance and sustainability attributes. In many jurisdictions, a third, ancillary pillar may emerge in the form of monetized environmental attributes, such as nitrogen pollution avoidance credits, carbon credits, or premiums associated with climate-smart agriculture programs. The net effect is a multi-line revenue profile that helps decouple project economics from any single commodity, crop, or policy instrument.

Sedron Technologies exemplifies this new model.

Sedron Technologies

“Sedron’s Varcor system efficiently converts nitrogen-rich liquid streams into clean water and concentrated ammonium nitrate products.”

Sedron's Varcor system uses mechanical vapor recompression, a proven technology in thermal desalination and other industrial water applications, and adapts it for efficient nutrient recovery. In an agricultural application, the incoming nitrogen-bearing liquids are processed through an advanced evaporative cycle that separates them into three main outputs: a reclaimed water stream suitable for reuse in industrial or non-potable applications, a dry solid fertilizer with NPK value and soil health impacts, and a concentrated ammonia product that can be formulated into market-ready fertilizers. The ammonia fraction can be directed into organic fertilizer manufacturing and tailored into specialized products that support regenerative agriculture and climate-smart programs, most notably an organic ammonium nitrate. For dairy applications specifically, the feedstock is liquid dairy manure that would otherwise sit in an open lagoon, which becomes the raw material for an organic fertilizer product.

This waste-to-value framing is the core of the dairy opportunity. Dairies generate large volumes of liquid manure that are expensive and increasingly difficult to manage, particularly in nitrate-sensitive watersheds where land application is capped or restricted. Rather than treating the manure purely as a disposal cost, a Varcor facility sited at or near a dairy converts that manure into saleable outputs: reclaimed water, a dry solid fertilizer, and a concentrated liquid organic ammonium nitrate fertilizer. The dairy pays a tip fee for processing, Sedron earns processing and product revenue, and the fertilizer buyer gets a traceable, domestically produced organic ammonium nitrate. It is a circular model: a sector long associated with nutrient pollution becomes a domestic supplier of the fertilizer that farmers and growers need.

SEDRON'S VARCOR SYSTEM, DEPLOYED AT SCALE

The Varcor system combines separation, concentration, and productization in a compact, energy-efficient package. The technology is designed to handle challenging feedstocks while producing a consistent analyzable fertilizer product that meets agricultural specifications. Sedron’s flagship product is an OMRI-listed organic liquid ammonium nitrate that works with existing irrigation and agronomic equipment, reducing adoption friction and letting buyers focus on the benefits of traceability, regional supply, and lower embedded emissions. Growers can apply it at the agronomic rate and time that support efficient plant uptake, leading to healthier crops, higher yields, and better-quality produce. Because the nitrogen is already in ammonium and nitrate form, it is more readily plant-available than many organic alternatives, which require mineralization first.

Energy savings and a circular solution for dairy waste

“A lower-energy path to nitrogen, and a cleaner way to handle dairy waste.”

The environmental case for this model runs on two separate tracks, and both matter to investors evaluating the decarbonization thesis. The first is energy. Conventional ammonia is manufactured through the Haber-Bosch process, a reaction run at high temperature and pressure in large, centralized plants and among the most energy- and natural-gas-intensive steps in industrial chemistry. A Varcor system does not synthesize new ammonia; it recovers ammonia nitrogen that already exists in the manure using mechanical vapor recompression, a comparatively efficient separation technology. The energy required per pound of usable nitrogen is materially lower than the conventional route, and because the facility sits at or near the dairy, there is little of the transportation-related energy and emissions that come with shipping fertilizer from centralized production hubs to farms.

The second track is waste handling. Left untreated, dairy manure is typically stored in open lagoons and applied to croplands in the spring and fall months for beneficial reuse. During long term storage, anaerobic breakdown releases methane and partial nitrification releases nitrous oxide, which is nearly 300x more potent than carbon dioxide[2], and land application during the wetter months of the year creates an ongoing risk to local water quality and nitrate-sensitive watersheds. Routing that manure through a Varcor facility as it is being collected instead avoids extended lagoon storage, cuts the associated emissions, and converts what has historically been an environmental liability into a revenue-generating input stream. The result is a circular system in a literal sense: waste in, decarbonized organic fertilizer out. In addition, this allows farmers to have a higher density of cows per acre and still achieve environmental requirements.

SEDRON'S DAIRY FACILITY

[2] IPCC

Customer needs and buying criteria

“Value streams from recovered fertilizers appeal to a wide range of agricultural stakeholders.”

Evaluating the opportunity in nutrient-recovered fertilizers requires a clear understanding of how different customers make decisions.

For industrial operators that generate nitrogen-rich streams, the primary objectives are cost control, regulatory compliance, and operational simplicity. They value predictable, per-unit pricing over long terms, turnkey solutions that minimize internal capital deployment and specialized staffing, and proven technologies with clear performance guarantees. For this group, contracting with a platform such as Sedron on an infrastructure-as-a-service basis is attractive: the platform finances, designs, builds, owns, and operates the facility, while the dairy pays a contracted processing fee and transfers a significant portion of technical and operational risk to the developer.

Farmers and agricultural buyers evaluate the product on a different set of criteria but arrive at an equally favorable view. Because Sedron’s liquid ammonium nitrate is not tied to a narrow application window the way many conventional dry fertilizers are, growers can spread it across the growing season rather than concentrating applications into a single pass. Its liquid form also allows it to be applied directly through the farm’s existing sprinkler or drip irrigation system, which removes the need for a separate tractor pass or dedicated spreading equipment and lets growers fertigate on their own schedule. Supply security is the third piece of the pitch: the product is manufactured domestically at dairies across the country rather than imported through global commodity channels, giving growers a source of nitrogen that is largely insulated from the natural gas price swings and shipping disruptions that periodically hit conventional, import-exposed fertilizer supply.

A successful platform is one that can translate all of these requirements into bankable facility designs and contracts, while maintaining stable cash flows across different market conditions.

Ara Partners' investment thesis in fertilizers and nutrient recovery

"Nutrient recovery and liquid ammonium nitrate fit well into Ara's core investment criteria and have the potential to scale meaningfully."

Ara Partners focuses on platforms that combine technology, operating capability, and market access in sectors with clear decarbonization potential. Nutrient recovery and low-carbon fertilizers align with this strategy along several dimensions. Demand for fertilizer and nitrogen management is non-discretionary; it underpins global food production in all market conditions, providing a strong foundation for service-fee and product-sale revenues. Properly structured facilities can earn from multiple sources - processing fees, fertilizer sales, water reuse, and potentially environmental attributes - reducing reliance on any single commodity or policy support mechanism. Because recovered fertilizer products displace fossil-intensive incumbents and operate with significantly lower energy requirements, their emissions reductions are tangible and measurable, enabling participation in emerging low-carbon input and climate-smart agriculture programs. Finally, the combination of technology development, permitting, project finance, and operational complexity involved in deploying advanced nutrient-recovery facilities at scale creates meaningful barriers to entry. Proven technology, long-term contracts, and reference plants can anchor defensible positions as the sector matures.

Ara's role is to help companies like Sedron move from being primarily technology developers to becoming scaled infrastructure platforms through disciplined process technology rollouts. This means supporting the transition from first-of-a-kind projects to a portfolio of nth-of-a-kind facilities, with standardized designs, lower capital costs, and faster execution and ramp-up.

The Ara advantage

"Ara's unique experience gives us pattern recognition of which PTRs work best, where customer demand is strongest, and how best to structure them for scale."

Ara has built a portfolio that is focused squarely on industrial decarbonization, including energy efficiency, low carbon fuels, circular materials, and process improvements. Our senior investment professionals have on average 25+ years of investing experience and have evaluated thousands of deals across the decarbonization landscape, backing multiple PTR platforms such as onshoring North American permanent magnet production and cement decarbonization businesses.

Where most firms advise, Ara builds - bringing unmatched industry depth and hands-on portfolio leadership to every investment. Ara Portfolio Services (APS) functions work in lockstep to provide project execution and operational optimization, commercial and policy expertise, and rigorous carbon accounting to unlock growth for the portfolio at an industrial scale.

ARA PARTNERS AT A GLANCE

Private equity

Infrastructure

Energy

Project execution & operations

Decarbonization

Government affairs

Investor expertise

The Ara advantage

"Ara brings a distinctive track record in delivering PTRs at a pace and scale that is rare in industrial decarbonization."

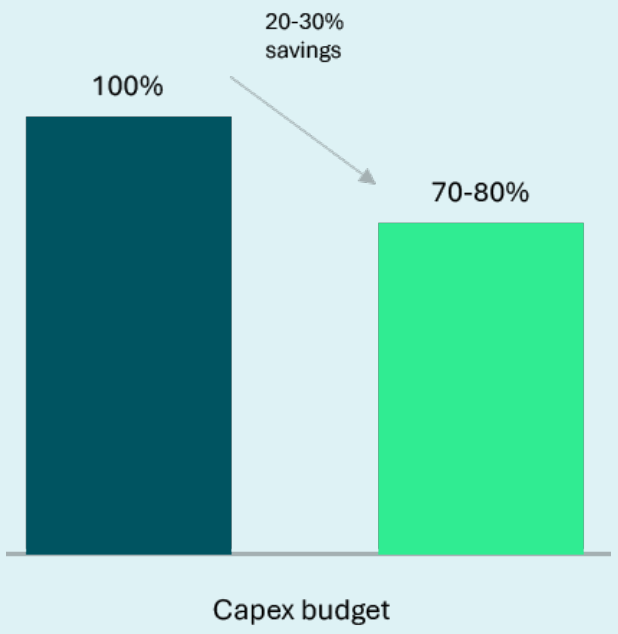
Project execution and operations

The Ara project execution and operations (APEX) group oversees capital project delivery and is a catalyst for project and operational maturity. APEX helps portfolio companies design and run capital projects using a standardized toolkit, from pre-deal cost and schedule analysis through commissioning. APEX's objective is straightforward: achieve commercially modeled capacity in the fastest and most cost-efficient way possible. For Nth-of-a-Kind (NOAK) plants, Ara targets 20-30% CapEx savings.

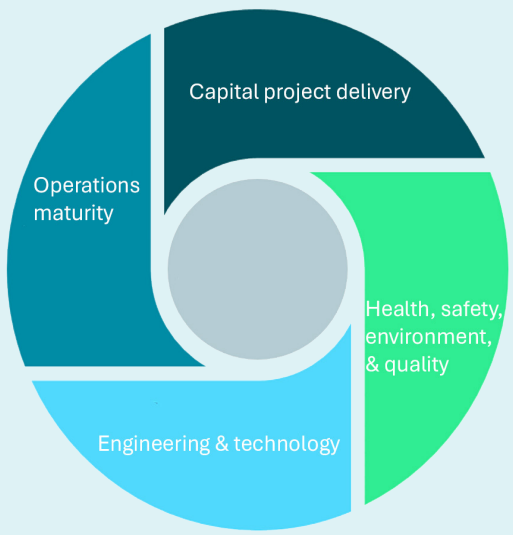
The team brings deep experience in project development, EPC, operational readiness, safety, and systems. It has overseen about $4.9 billion of development CapEx across 29 start-ups, with 75 projects across Ara and more than 400 industrial projects delivered over their experience.

This on-the-ground activity, spread across sectors and geographies, gives Ara a practical base from which to run and refine PTR programs at pace and scale.

BUILD FASTER, BUILD FOR LESS: TARGET ARA CAPEX SAVINGS



CORE APEX FOCAL AREAS



The Ara advantage

"Ara brings the complete resources of the firm to ensure each PTR is successful - a support system that is differentiated and rare in private equity."

Decarbonization

Our decarbonization team ensures that assets deliver measurable emissions reductions and helps portfolio companies turn that impact into revenue. In addition to robust baselining and monitoring, reporting, and verification, we help identify and monetize environmental attributes in both voluntary and compliance carbon markets. That can unlock an incremental, recurring, high-margin revenue stream through carbon credits or other instruments that reflect the emissions performance of the plants. When structured correctly, this revenue improves project economics and can make lower-carbon products more competitive against fossil incumbents.

Commercialization services

Ara's commercialization support is built around partnerships, not just transactions. We help portfolio companies:

> identify and engage strategic commercial partners

> set up customer and industry advisory councils to accelerate traction and strengthen the brand

> sharpen product market fit, route to market, and pricing strategies

> structure and negotiate offtake agreements that support financing and leave room for multi-plant growth

The aim is to move from one-off sales to durable commercial relationships that support the entire PTR roadmap.

Government affairs

Ara's government affairs capability identifies and capitalizes on relevant policies, tax incentives, subsidies, grants, and regulatory opportunities, and integrates them into project design, siting, workforce development, and financing structures. This speeds up incentive capture, reduces permitting risk, and makes it easier to replicate structures across multiple projects and jurisdictions. Access to non-dilutive capital enhances Ara's returns.

[3] Plant picture: Genera plant built with Ara Partners' PTR model

Conclusion

“From overlooked liability to generational investment opportunity in climate-smart fertilizers.”

Nutrient recovery, lower carbon fertilizers, and organic liquid ammonium nitrate tell a story of how externalities become infrastructure. For decades, the world relied on conventional fertilizers produced in carbon-intensive facilities, while discarding or underutilizing nitrogen streams embedded elsewhere in the economy. Agricultural and industrial stakeholders alike are looking for solutions that do more than shift nitrogen from one place to another; they want systems that recover value, reduce emissions, and support long-term resilience.

That demand is creating space for a new class of infrastructure: plants, pipelines, contracts, and offtake agreements that treat nitrogen-rich streams as valuable feedstock rather than pure waste. For investors willing to look beyond the more visible corners of the energy transition, nutrient recovery and liquid ammonium nitrate production are beginning to look like durable, scalable ways to align capital with climate impact and food-system resilience. The question is not whether this market will develop - it is already doing so - but how quickly agricultural producers, industrial operators, regulators, and capital providers can move to replace a strained, fossil fuel-centric status quo with the next generation of circular, critical infrastructure. Sedron Technologies, backed by Ara Partners, is positioned to be one of the platforms leading that shift.

Ara Built to Decarbonize.®

About Ara Partners

Founded in 2017, Ara Partners is a global private markets firm focused on decarbonizing the industrial economy. We invest in the middle market across three strategies: Private Equity, Infrastructure, and Energy. We scale commercially demonstrated decarbonization solutions, support the businesses and infrastructure that enable their adoption, and reduce emissions at the source across the conventional energy value chain. Our model combines investing, market and policy expertise, project execution and operational optimization, and rigorous carbon accounting to reduce emissions economically and unlock growth at an industrial scale. Ara operates from Houston, Boston, Dublin and Washington D.C.