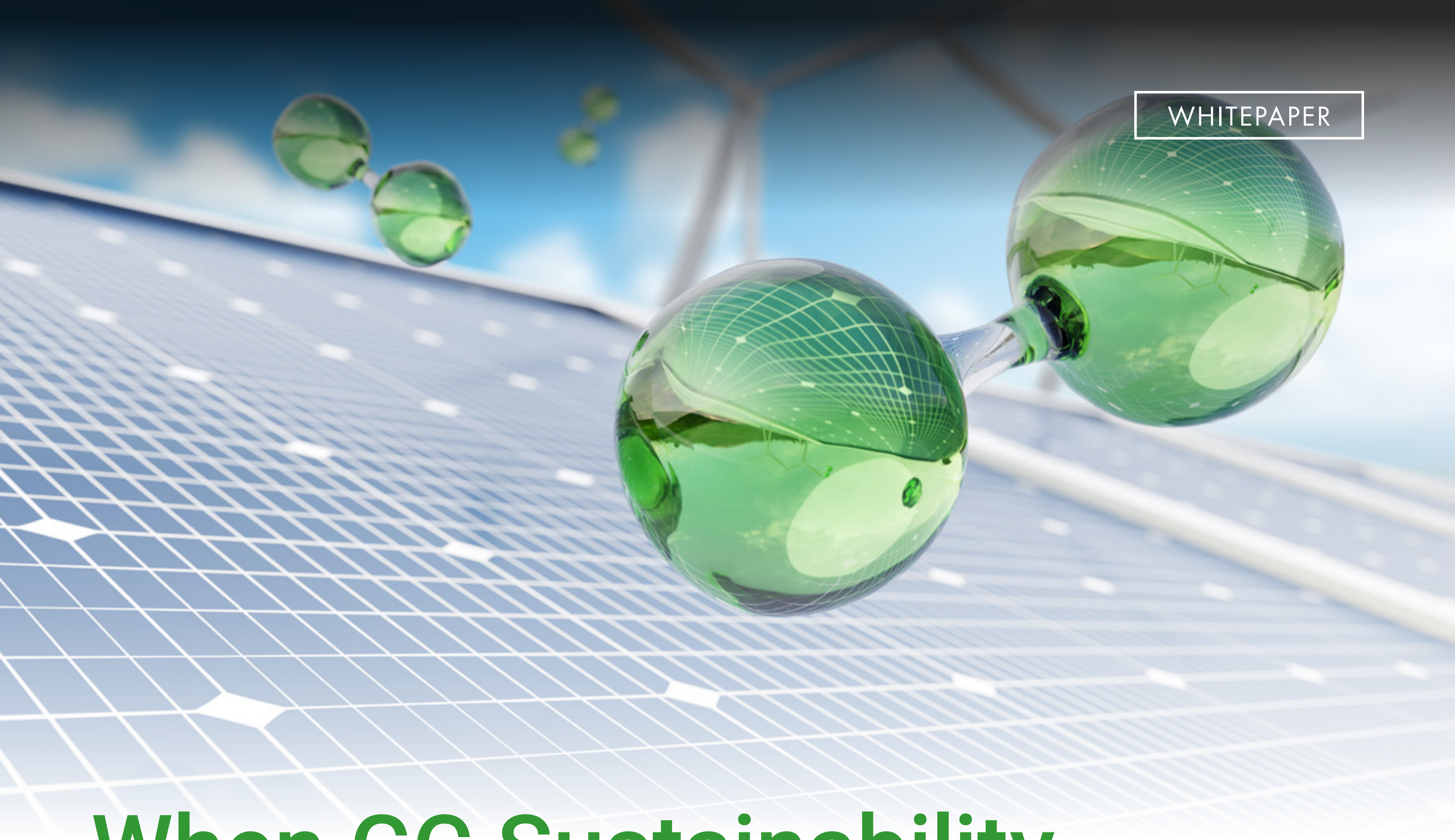
WHITEPAPER



When GC Sustainability Also Means Better Uptime

On-site hydrogen cuts emissions and steadies analytical workflows beyond what delivered helium offers

Gas chromatography (GC) labs face rising sustainability expectations while keeping budgets in line. Reliance on helium forces a trade-off they cannot control. Most rely on helium as their carrier gas, but its supply chain—gas fields, cryogenic plants, and truck deliveries—brings carbon, price swings, and the risk of sudden shortages that can halt work overnight.

On-site hydrogen generation shifts sourcing decisions back to the lab. It replaces recurring deliveries with point-of-use supply from water and power, giving GC operations predictable costs and a carbon footprint shaped by their own energy choices. The five points below show where that shift has the most impact.

Helium scarcity is structural, not temporary

Helium shortages have recurred for more than 20 years, most recently the so-called "Shortage 4.0," and each cycle has forced GC teams to stretch cylinders and absorb higher costs. The pattern persists because helium is a finite resource found in a narrow set of natural gas fields. When production slows or exports shift, supply to labs tightens.

The strain keeps building because helium serves industries with few substitutes. MRI and NMR systems depend on it for cooling. Particle physics, fusion research, and quantum cryostats need its cryogenic properties. Semiconductor manufacturing, EV battery leak testing, fiber optics, and aerospace welding also use it in critical workflow steps. As demand grows in these fields, the supply left for analytical labs keeps shrinking.

Forecasts point to a harder future. The market research firm IDTechEx projects that global helium demand will almost double between 2024 and 2035, while production remains concentrated in regions with clear geopolitical risk. Conservation will cut losses in some fields, but most recovered helium stays in the facilities that capture it.

Changing the carrier-gas origin story

Extracting natural gas and recovering helium as a by-product releases greenhouse gases and disturbs land and water. That impact extends past the wellhead. Embedded emissions show up in sustainability reports that track both on-site energy use and carbon loads tied to purchased goods. Most emissions in biotech and pharma now fall in that off-site category, and delivered gases are part of it.

On-site hydrogen generation eliminates upstream extraction. The lab makes ultra-high purity (UHP) hydrogen gas using electrolysis cells that run on deionized water and electricity. The cell splits water into hydrogen at the cathode and oxygen at the anode, separated by a proton exchange membrane. The stream then moves through purification and drying beds that remove oxygen, moisture, and trace gases so the output reaches GC-grade purity.

The result is a more controlled footprint. Generation depends on internal sources rather than upstream extraction and liquefaction. A small low-pressure buffer feeds the instrument, reducing reliance on large cylinders and giving the lab a supply it can oversee directly.

Delivery routes drive cost and carbon

Most GC labs receive cylinders by commercial van or small truck, and those deliveries add up fast. A delivery truck running 50,000 miles per year at 7 MPG emits roughly 63.5 metric tons of CO_2 annually, using EPA's emissions factor of 8,887 g per gallon of gasoline.

Most GC budgets still treat UHP gas in terms of price per tank. Parker's own cost model reveals hidden expenses. A lab that uses two $300 cylinders each month spends over $7,000 per year on gas alone, but demurrage, shipping, paperwork, and cylinder handling push the total to about $12,850.

The same model estimates about $900 per year to run a generator, mostly for filters and routine service. Carrier gas shifts from a recurring planning task to a maintenance line item, reducing operational costs and emissions.

Cryogenic helium separation locks in high energy use

Helium only reaches the lab after a deep cooling step. Once separated from natural gas, it must be liquefied and kept near 4 K for bulk transport and storage. A 2023 analysis from the ISIS Neutron and Muon Source puts the footprint of liquid helium delivered this way at roughly 700 g CO_2 per liter, versus about 500 g CO_2 per liter for helium recovered and reliquefied on site.

Labs then lose part of that product before it ever reaches an instrument. As liquid helium moves through drums, dewars, and transfer lines, heat leaks drive evaporation that vents away. Even small percentage losses across many fills and transfers add up in cost and in carbon. The effective footprint per liter that reaches the bench is higher than the production figures suggest.

Modern generators such as Parker's ChromGas™ systems provide hydrogen for both carrier gas and detector fuel applications. The H2C (hydrogen carrier) series reaches up to 99.99999 percent purity (based on oxygen content) for carrier gas, while the H2F (hydrogen fuel) series delivers 99.9995 percent purity for fuel applications such as flame ionization detector (FID) operation. Both include drying trains that keep detector response steady. Stackable cabinets reclaim bench or floor space that dewars and spare cylinders once occupied.

Making the transition measurable

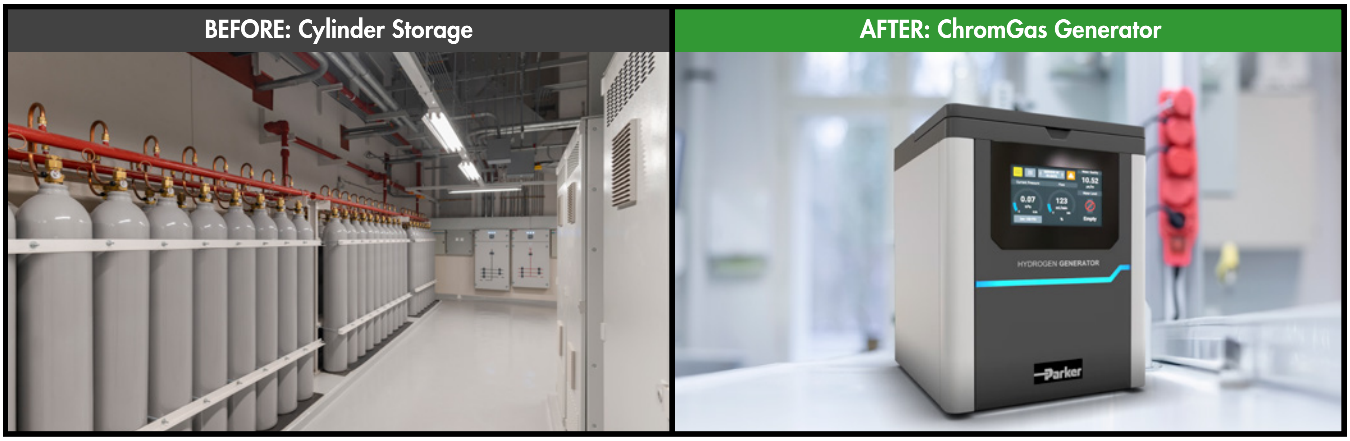
Sustainability in analytical science depends on choices that support data quality and operational stability. Producing hydrogen gas in-house cuts waste tied to transport, cryogenic handling, and boil-off, while shifting the remaining impact into the lab's own energy use. Gas generation gives managers direct control over a cost and emissions source rather than accepting the footprint of external supply chains.

Parker Hannifin has been making the same shift inside its own business. Since FY19, the company has reduced its in-house energy and process emissions by 23 percent and is targeting carbon-neutral operations by 2040. Its Design for Environment framework integrates energy use, materials, and lifecycle impact into technology development from the start, including hydrogen generators.

For detailed conversion data and implementation guidance, see Parker's Helium to Hydrogen Conversion Guide.

Delivered Helium vs. On-Site Hydrogen: 5 Key Differences

Factor	Delivered helium	On-site hydrogen
Gas source	Drawn from natural gas fields; finite and tied to fossil fuel markets.	Made from deionized water on site; depends on local utilities.
Extraction process	Wells, pipelines, and processing plants add upstream emissions and land impact.	Electrolysis only; no drilling or flaring tied to the hydrogen gas.
Transportation	Frequent cylinder or dewar shipments; fuel use and handling time stack up.	One generator delivery; routine gas freight elimintaed.
Energy use	Large power draw at off-site plants for separation and cooling.	Minimal electrical load at the lab; easy to track and optimize.
Waste	Boil-off and residual gas left in containers increase cost and emissions.	Gas made as needed with minimal loss during storage or transfer.



BEFORE: Cylinder Storage

AFTER: ChromGas Generator

ChromGas H2F generators deliver 99.99999 percent pure hydrogen at flow rates from 100 to 510 ml/min. Water consumption ranges from 0.75 to 4 liters per week depending on model. All units share a compact 17.1" × 13.5" × 18" footprint and include a 3-year cell warranty.

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To explore in-house gas solutions for GC, visit **parker.com/labgas**