neo-H2

HR-100: Real-World Applications

Where a compact methanol-to-hydrogen reformer can create value, and what a developer would need to take it to market

- Farm and agricultural microgrid
- Hydrogen at the fuel station
- Mars, space and off-world ISRU
- Off-grid power
- Backup power for data centers and hospitals
- Marine and port power
- Military and forward-operating-base power
- Material handling
- Disaster relief and emergency power



HR-100 prototype cabinet (photograph)

Available for acquisition, licensing or technology transfer.

Neo-H2, LLC · Charlotte, North Carolina · Non-confidential overview

The HR-100 at a glance

The HR-100 is a compact autothermal reformer. It combines methanol, steam and air, recirculates its own water, and produces a hydrogen-rich gas (syngas) on site. After standard purification, that hydrogen can run a fuel cell, or a generator where a fuel cell is not practical. Methanol is a liquid at ambient conditions, so it can be trucked, stored in ordinary tanks and turned into hydrogen only where and when it is needed. That single idea, liquid fuel in and hydrogen out at the point of use, is what links every application in this document.

33–36%
H_2 in the product gas, measured on cylinder samples by an independent US lab

8–12 kg
H_2 per day output per HR-100 unit

350+ h
of reforming across 100+ tests

10.5 h
longest continuous run

6
hardware iterations

TRL 4–5
technology readiness

CORE PROCESS

Methanol + water ▶ **HR-100 reformer** ▶ **H_2-rich syngas** ▶ **Purification** ▶ **Fuel cell** ▶ **Power**

Fuel cell is the lead downstream use; a hydrogen-ready generator is a secondary option. Purification uses standard units such as PSA or membranes.

HONEST BOUNDARIES

- Tested on methanol only. Other fuels were tried at lab scale only; any other feedstock would need development.
- Larger units (10–20× output) are a projection and have not been built. A prior internal analysis estimated that a 10× unit would cost only about 5–6× as much (an estimate, not a quote).
- The reformer is air-fed, so its exhaust CO_2 is diluted with nitrogen. That suits algae and greenhouse use; capturing pure CO_2 would need an oxygen-fed variant.
- Detailed test data is available only under NDA.



HR-100 prototype cabinet (photograph).

Principal inventor: Dr. Bojidara Grigorova, whose background includes research at Anglo American Research Laboratories.

APPLICATION 1

Farm and agricultural microgrid

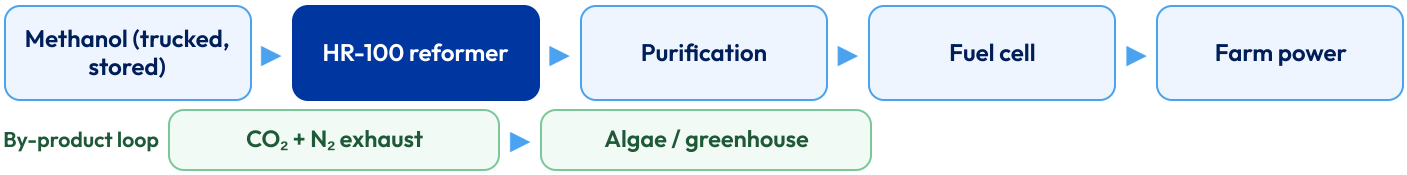
Concept from Neo-H2 founder Dr. Steven Kadiev

THE NEED

Farms, ranches and agricultural processors often sit at the end of weak grid lines, run diesel generators for irrigation, cold storage and processing, and pay for CO_2 if they run greenhouses. Greenhouse growers commonly enrich air with CO_2 to around 800–1,000 ppm to support crop growth [9].

HOW THE HR-100 FITS

Methanol is trucked in and stored in a standard tank. The HR-100 reforms it on site into hydrogen-rich gas, which is purified and fed to a fuel cell for farm power, with a generator as a secondary option. The CO_2-bearing exhaust is routed to algae ponds or a greenhouse, turning a by-product into a growth input. Because the exhaust is diluted with nitrogen, it fits this use well without any need for pure CO_2.



WHAT A DEVELOPER WOULD BUILD OR ADAPT

- Integrate the reformer with an off-the-shelf purification unit and fuel cell into one skid or container.
- Exhaust handling and CO_2 dosing controls for a greenhouse or algae system.
- Battery buffer for load swings and start-up, plus remote monitoring for unattended sites.
- Field validation on a working farm, and local permitting for methanol storage.

LIKELY BUYERS AND LICENSEES

- Agricultural equipment makers
- Controlled-environment / greenhouse integrators
- Rural microgrid developers
- Algae and bio-products companies
- Rural electric cooperatives

WHY IT IS COMPELLING

Two outputs from one fuel
Electric power for the farm plus CO_2 for algae or greenhouse growth.

Familiar logistics
Methanol is delivered by truck and kept in a standard tank; no hydrogen pipeline or tube trailers.

Right-sized
Rough sizing (illustrative arithmetic, not a test result): 8–12 kg H_2/day through a typical fuel cell is roughly 4–8 kW of continuous power.

Maturity note. Concept stage for this use. The reformer has been tested on methanol at TRL 4–5; the full farm system (purification, fuel cell, CO_2 routing) has not been assembled or tested.

APPLICATION 2

Hydrogen at the fuel station

Concept from Neo-H2 founder Dr. Steven Kadiev

THE NEED

Most hydrogen stations depend on trucked compressed or liquid hydrogen. In California, a gaseous supply disruption took 21 stations offline at once [7], and retail prices at one major network were recently cut to $25.99–$29.99 per kg [8]. Station developers want a steadier, cheaper supply.

HOW THE HR-100 FITS

Methanol is stored in the station's existing underground tanks, like any other liquid fuel, and reformed on site into hydrogen for fuel-cell vehicles. This avoids hauling compressed hydrogen. A car takes 1–5 kg per fill [8], so one HR-100 serves a handful of fills a day; a commercial station would need the larger 10–20× units (projected) or several units in parallel.



WHAT A DEVELOPER WOULD BUILD OR ADAPT

- Scale-up to 10–20× output, or a parallel multi-unit design.
- High-purity purification to fuel-cell-vehicle hydrogen quality standards.
- Compression, buffer storage and dispensing, integrated with station controls.
- Tank compatibility review for methanol in existing underground storage, and code approvals.

LIKELY BUYERS AND LICENSEES

- Hydrogen station developers and operators
- Fuel retailers and convenience chains
- Industrial gas companies
- Fleet depots (buses, trucks, municipal)
- Methanol producers seeking new outlets

WHY IT IS COMPELLING

Liquid logistics
Methanol moves in ordinary tanker trucks and sits in the station's existing underground tanks.

Supply resilience
Making hydrogen on site removes dependence on compressed-hydrogen trailer deliveries [7].

Existing real estate
Builds on fuel-retail sites, permits and customer traffic that already exist.

Maturity note. Concept stage for this use. Needs the largest development effort of the ground-based options: scale-up, vehicle-grade purification and dispensing. The pain point it addresses is real and current.

APPLICATION 3

Mars, space and off-world ISRU

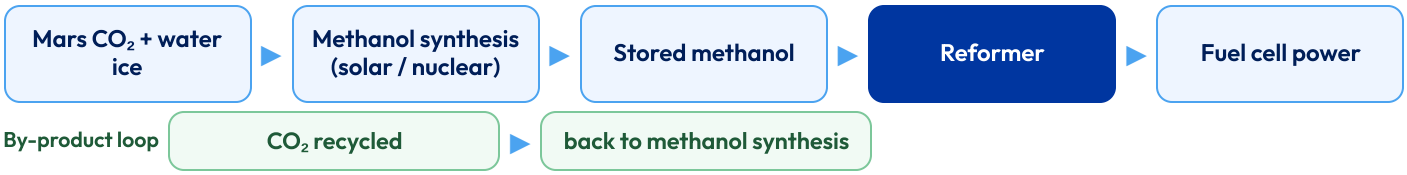
Long-horizon opportunity

THE NEED

Any long stay on Mars needs power and fuel made from local resources (in-situ resource utilization, ISRU). Shipping hydrogen is hard; storing it is harder. NASA's MOXIE instrument has already shown that oxygen can be made from Martian CO_2 on the surface [10], and NASA has backed Mars methanol work through its small-business programs [11].

HOW THE HR-100 FITS

Methanol can be made on Mars from atmospheric CO_2 and water ice using solar or nuclear power, giving an easy liquid to store. When power is needed, a reformer turns it back into hydrogen for fuel cells, and the CO_2 is captured and recycled into more methanol, a closed energy loop. Methanol acts as a storable "battery" for surplus solar or nuclear energy.



WHAT A DEVELOPER WOULD BUILD OR ADAPT

- Oxygen supply: Mars air is about 95% CO_2 with almost no oxygen, so the reformer would need stored or electrolysis oxygen (shared with life support), or a pure steam-reforming mode with outside heat.
- Engineering for very low ambient pressure, extreme cold and fine dust.
- CO_2 capture and recycle loop sized to the methanol synthesis step.
- Mass, power and autonomy optimization for flight hardware.

LIKELY BUYERS AND LICENSEES

- Space and aerospace prime contractors
- ISRU and space-resources start-ups
- Lunar and Mars surface-power developers
- University and government research labs

WHY IT IS COMPELLING

Closed energy loop
CO_2 and water in, energy stored as liquid methanol, CO_2 recovered and reused.

Easy storage
A liquid that keeps in simple tanks, instead of cryogenic or highly compressed hydrogen.

Earth stepping stones
The same concept could first serve remote research stations and other off-grid analog sites.

Maturity note. Earliest stage of all applications. The HR-100 is an air-fed, Earth-based prototype; the Mars version is a research concept. Possible development routes include NASA SBIR/STTR awards and NASA in-situ resource utilization programs.

APPLICATION 4

Off-grid power: telecom towers and remote sites

The need. Telecom towers, remote mining and construction camps and pipeline stations often run on diesel that must be trucked in often. Operators are already moving to methanol: Telefónica has piloted an off-grid base station on methanol-derived hydrogen with solar and batteries [3], and methanol-to-hydrogen power systems are being delivered to more than 1,000 base stations in the UAE [4].

How the HR-100 fits. This is the closest match to the HR-100 as built: a small, steady load, methanol delivered occasionally, and on-site hydrogen for a fuel cell.

Why it matters. Replaces frequent diesel runs with occasional methanol deliveries, in a market already buying methanol-to-hydrogen power at scale [4].

Methanol tank ▶ **HR-100 reformer** ▶ Purification ▶ Fuel cell + battery ▶ Tower / camp load

To build or adapt

- Package as an unattended, remotely monitored power unit.
- Hybrid controls with solar and batteries; ruggedizing for heat, cold and dust.

Likely buyers / licensees

Telecom tower companies

Off-grid power system integrators · Fuel-cell makers

Mining and construction services

Maturity note. Closest fit to current hardware. Requires productization and field trials, not new science.

APPLICATION 5

Backup power for data centers and hospitals

The need. Critical facilities keep diesel generators for outages and face a growing push to replace them. Microsoft ran a 3 MW hydrogen fuel-cell pilot that kept a data center online for two days, and further hydrogen fuel-cell sites are under way across the US [5]. Stored methanol avoids keeping large volumes of compressed hydrogen on site.

How the HR-100 fits. Methanol is held in tanks like diesel; when the grid fails, batteries carry the load while the reformer starts and feeds hydrogen to fuel cells.

Why it matters. Diesel-like fuel storage with a hydrogen fuel-cell output, for sites that do not want large volumes of compressed hydrogen.

Stored methanol ▶ **Reformer bank** ▶ Purification ▶ Fuel cells + UPS ▶ Critical load

To build or adapt

- Multi-unit or 10–20× scale-up for larger sites (projected).
- Fast-start strategy with battery bridging; integration with UPS and facility controls.

Likely buyers / licensees

Backup-power and UPS manufacturers

Fuel-cell system makers · Data-center developers

Hospital energy service firms

Maturity note. Attractive market, but larger sites need scale-up and long-duration validation.

APPLICATION 6

Marine and port power

The need. Methanol is one of shipping's main alternative fuels. DNV has counted more than 300 methanol-capable vessels on order, and more than 450 on order or in operation [1][2]. Ports need cleaner power for berthed ships, cranes and harbor craft.

How the HR-100 fits. Where methanol is already bunkered, an HR-100-type unit could make hydrogen for fuel-cell auxiliary power on board, or for shore power and port equipment.

Why it matters. Uses the methanol bunkering network that is already being built, rather than waiting for hydrogen bunkering.

Bunkered methanol ▶ **Reformer** ▶ Purification ▶ Fuel cell ▶ Auxiliary / shore power

To build or adapt

- Marine classification and approvals; motion and salt-air design.
- Scale-up for larger vessels and port loads.

Likely buyers / licensees

Marine power-system suppliers

Shipyards and ship designers

Port authorities and terminal operators

Maturity note. Strong fuel tailwind, but marine approval is a long process. Note that green-methanol supply is still catching up with ship orders [2].

APPLICATION 7

Military and forward-operating-base power

The need. Forces need quiet, low-signature power with fewer fuel convoys. Methanol fuel-cell systems are already in military service; one European maker recently won the largest order in its history for such systems for defense and civilian use [6].

How the HR-100 fits. An HR-100-type reformer turns a storable liquid into hydrogen for fuel cells at a base or command post, at a larger output than portable direct-methanol units.

Why it matters. More output than portable methanol fuel cells, from the same storable liquid fuel.

Methanol supply ▶ **Ruggedized reformer** ▶ Purification ▶ Fuel cell ▶ Base / command-post power

To build or adapt

- Ruggedizing, compact packaging and signature reduction.
- Operation on logistic fuels would need feedstock development (tested on methanol only).

Likely buyers / licensees

Defense prime contractors

Tactical power suppliers

Government research labs

Maturity note. Clear demand signal; defense qualification and any non-methanol fuel capability need significant work.

APPLICATION 8

Material handling: hydrogen for warehouse forklifts

The need. Fuel-cell forklifts are an established market: one supplier alone reports more than 76,000 fuel-cell systems deployed across more than 280 customer sites [12]. Most of these sites buy delivered hydrogen.

How the HR-100 fits. On-site methanol reforming could replace delivered hydrogen at a distribution center, with methanol trucked and stored like any liquid fuel.

Why it matters. Turns a large, existing base of fuel-cell forklift users into customers for on-site hydrogen.

Methanol tank ▶ **HR-100 reformer(s)** ▶ Purification ▶ Compression & dispenser ▶ Fuel-cell forklifts

To build or adapt

- Purification to fuel-cell grade, compression and indoor dispensing.
- Multi-unit or scaled design sized to fleet demand; site codes and approvals.

Likely buyers / licensees

Fuel-cell forklift makers · Industrial gas companies · Logistics and warehouse operators

Maturity note. Large existing buyer base; needs the same purification and dispensing work as the fuel-station case, at smaller scale.

APPLICATION 9

Disaster relief and emergency power

The need. After storms, floods and wildfires, shelters, clinics and communications need power for days or weeks, often where the grid and fuel deliveries are disrupted.

How the HR-100 fits. A trailer-mounted reformer and fuel cell running on stored methanol could deliver steady power with infrequent refueling, and stand by in storage between events.

Why it matters. Methanol keeps in ordinary drums or tanks between events, so units can stand ready.

Stored methanol ▶ **Trailer-mounted reformer** ▶ Purification ▶ Fuel cell + battery ▶ Shelter / clinic power

To build or adapt

- Mobile packaging, quick set-up and long-term standby readiness.
- Simple operator interface for non-specialist crews.

Likely buyers / licensees

Mobile power rental companies · Emergency-management equipment suppliers · Utilities and relief organizations

Maturity note. Good fit with current unit size; needs productization and field trials.

Comparing the applications

A side-by-side view to help a developer choose a first market and a follow-on path.

#	Application	Fit with current HR-100	Development needed	Market attractiveness
1	Farm / agricultural microgrid	Medium–High	Medium	Medium
2	Fuel station hydrogen	Medium	High	Medium
3	Mars / space ISRU	Low	Very high	Low (strategic)
4	Off-grid telecom & remote sites	High	Low–Medium	High
5	Backup power: data centers, hospitals	Medium	Medium–High	High
6	Marine & port power	Medium	High	Medium
7	Military / forward-base power	Medium	High	Medium
8	Warehouse forklifts	Medium	Medium–High	High
9	Disaster relief & emergency power	High	Low–Medium	Medium

Ratings are Neo-H2's qualitative judgment, not market studies. “Fit” means fit with the HR-100 as built (methanol feed, 8–12 kg H_2/day). “Development needed” covers integration, scale-up, purification and approvals. “Market” reflects near-term buyer demand and size.

Where to start: off-grid telecom and remote-site power and emergency power match the current unit size most closely and need the least new engineering. The farm microgrid adds a distinctive CO_2-reuse story. Fuel stations, forklifts and backup power open larger markets once a scaled unit is developed.

SCALE-UP PATH (PROJECTION)

HR-100

Built and tested on methanol: 8–12 kg H_2/day, TRL 4–5.

10–20× units

Projected, not built. Parallel units are another route to larger output.

~5–6× cost for 10× output

Estimate from a prior internal analysis, not a quote.

Other options worth exploring with further development: on-site hydrogen or syngas for small industrial users, and an oxygen-fed variant whose concentrated CO_2 exhaust would be easier to capture.

Available for acquisition, licensing or technology transfer

Neo-H2 is offering the HR-100 to a company that will develop and commercialize it. The technology suits a developer with integration, manufacturing or market access in any of the applications above.

Acquisition
Purchase of the HR-100 technology and related materials.

Licensing
Exclusive or non-exclusive licenses, by field of use and region.

Technology transfer
Transfer of the prototype, data and know-how to a developer that will commercialize it.

NEXT STEPS

1 · NDA — Mutual non-disclosure ▶ **2 · Data room** — Test data and design history ▶ **3 · Evaluation** — Technical and commercial review

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REFERENCES (MARKET SIGNALS)

1. **World Ports Organization**, The Week in Alt Fuels: The cold feet conundrum (DNV fleet and orderbook data). https://www.worldports.org/the-week-in-alt-fuels-the-cold-feet-conundrum/
2. **The Maritime Executive**, The Ship Has Outpaced the Fuel. https://maritime-executive.com/magazine/the-ship-has-outpaced-the-fuel
3. **Telefónica**, Hydrogen and methanol: clean energy for off-grid base stations. https://www.telefonica.com/en/communication-room/blog/hydrogen-methanol-clean-sustainable-energy-grid-base-stations/
4. **Hyvoda**, 45 kW methanol-to-hydrogen power for UAE telecom towers. https://hyvoda.com/uae-telecom-methanol-hydrogen-power/
5. **Data Center Knowledge**, Hydrogen's hurdles, fuel cells' rise in data center power. https://www.datacenterknowledge.com/uptime/hydrogen-s-hurdles-fuel-cells-rise-in-data-center-power
6. **Hydrogen Fuel News**, SFC Energy secures record €42.7M DMFC order. https://www.hydrogenfuelnews.com/sfc-energy-secures-record-e42-7m-dmfc-order-for-ukraine/8575965/
7. **H2FCP (California hydrogen station network)**, California hydrogen network update (supply disruption). https://h2fcp.org/blog/california-hydrogen-network-update
8. **H2FCP (California hydrogen station network)**, Webinar Recap: State of the Hydrogen Network (station prices and fill sizes). h2fcp.org/blog
9. **USDA Agricultural Marketing Service**, Technical report: Carbon dioxide, crops (greenhouse CO_2 enrichment). https://www.ams.usda.gov/sites/default/files/media/CarbonDioxide_Crops.pdf
10. **NASA**, Mars Oxygen In-Situ Resource Utilization Experiment (MOXIE). https://www.nasa.gov/space-technology-mission-directorate/tdm/mars-oxygen-in-situ-resource-utilization-experiment-moxie/
11. **SBIR.gov**, NASA award: Mars in-situ based rocket propulsion using methanol. https://www.sbir.gov/awards/92705
12. **Plug Power, via StockTitan**, Company presentation in 8-K filing: GenDrive fuel cells deployed. https://www.stocktitan.net/sec-filings/PLUG/8-k-plug-power-inc-reports-material-event-b1666f310ca8.html

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