

WHAT ARE YOU BUILDING AND WHAT HAS ALREADY BEEN PROVEN?

Direct ammonia to electricity — starting with a 10 kW commercial-vehicle power system.

H2ONE is developing a low-temperature direct-ammonia AEM fuel-cell system that converts ammonia directly into DC electricity without an external hydrogen cracker.

● MEASURED PERFORMANCE

121 mW/cm²

25 cm² measured cell

● SYSTEM TARGET

10 kW NET

DAFC-10 system target

● VEHICLE RANGE ESTIMATE

≈178 km

10 kg NH₃, synthetic urban cycle

● INVESTMENT & TIMELINE

₹5 CRORE • 24 MONTHS

measured cell → stack → vehicle demonstrator



MEASURED CELL →
VEHICLE DEMONSTRATOR



Today: measured 25 cm² hardware.

This round: prove large-area retention, build DAFC-10 and demonstrate it on an L5 three-wheeler.

WHY DOES THE MARKET NEED ANOTHER POWERTRAIN?

Commercial three-wheelers earn when they move — energy replenishment determines utilisation.

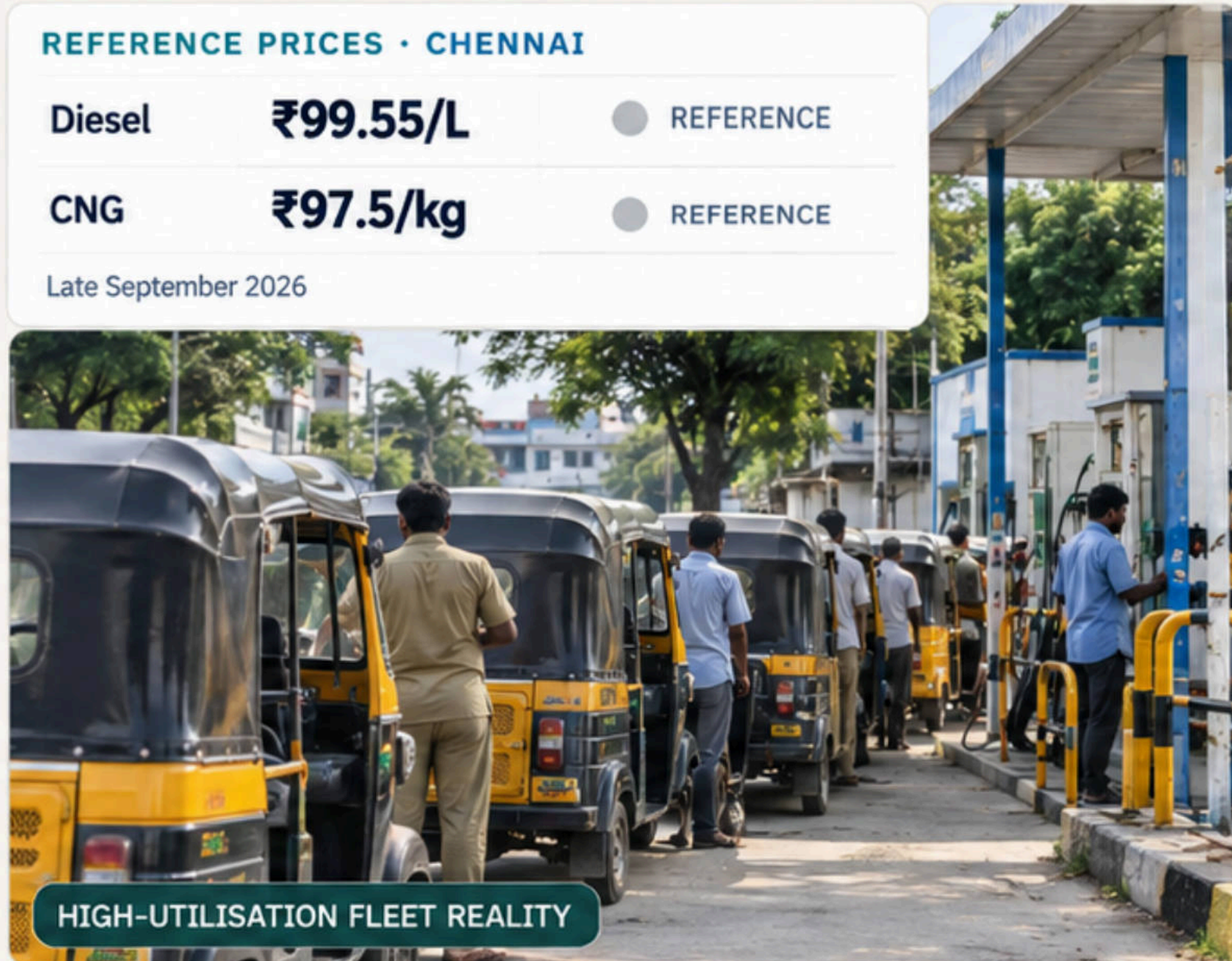
For high-usage fleet vehicles, downtime is an economic penalty.

REFERENCE PRICES • CHENNAI

Diesel **₹99.55/L** ● REFERENCE

CNG **₹97.5/kg** ● REFERENCE

Late September 2026



HIGH-UTILISATION FLEET REALITY

OPERATING-CONTEXT COMPARISON

Issue	Battery EV	CNG / diesel	H ₂ fuel cell	H2ONE DAFC
replenishment	charge / swap	minutes	minutes	target: minutes
tailpipe carbon	none	CO ₂	none	none
storage	battery pack	pressure tank	350–700 bar H ₂	moderate-pressure liquid NH ₃
infrastructure	strong / growing	mature	very limited	industrial NH ₃ exists; vehicle network absent
key constraint	charging / swapping / grid	fossil fuel + emissions	fuel + station cost	toxicity + technology maturity

H2ONE targets high-utilisation depot fleets where charging interruption has measurable economic value.

IS THE TARGET MARKET ALREADY LARGE?

Three-wheelers are already one of India's most electrified commercial-vehicle segments.

INDIA E-3W MARKET • REFERENCE

8.31 LAKH
e-3Ws in FY2026

● REFERENCE

≈19%

YoY growth

● REFERENCE

>60%

share of total 3W sales in FY2026

● REFERENCE

77,448

e-3Ws in June 2026

● REFERENCE

64.1%

June 2026 penetration

● REFERENCE

PM E-DRIVE L5 • POLICY CONTEXT (REFERENCE)

PM E-DRIVE L5 incentive closed after the scheme target was met post 26 Dec 2025.

Target: 2,88,809 L5 vehicles.

● REFERENCE



INDIA E-3W MARKET
HIGH-UTILISATION COMMERCIAL SEGMENT

MARKET MIX (REFERENCE)

● Electric (EV) ● CNG / LPG ● Diesel ● Other

FY2026
(total 3W sales)

> 60%
Electric (EV)

<40%
Other (CNG/LPG, Diesel, etc.)

June 2026
(retail mix)

64.1%
EV

22.2%
CNG / LPG

13.4%
Diesel

≈0.3%
Other

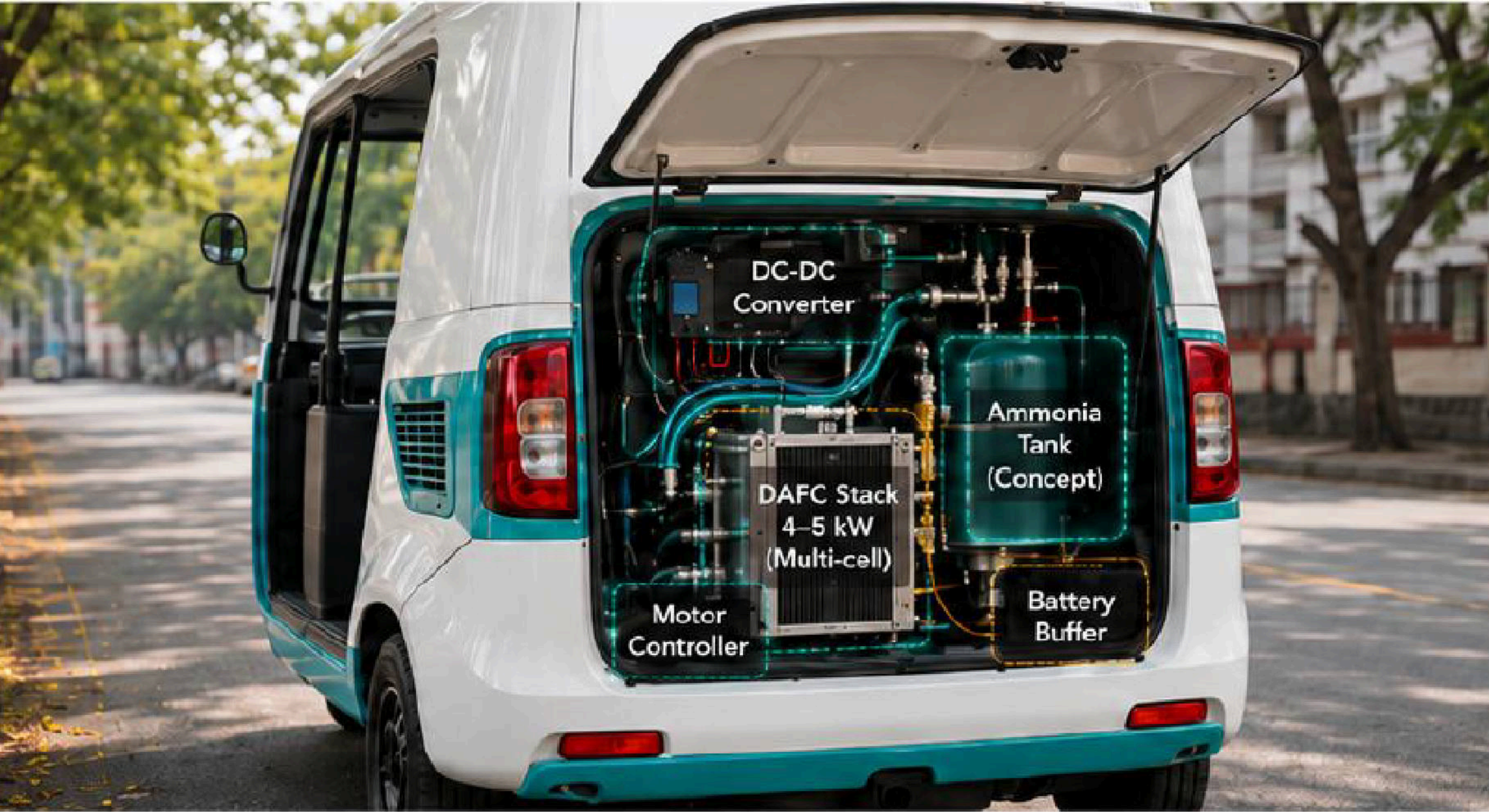
June 2026 retail mix

H2ONE does not need to persuade the market to accept an electric motor. It is competing on the energy carrier feeding that drivetrain.

SOURCE: VAHAN / FY2026 MARKET REPORTING; FADA JUNE 2026 RETAIL DATA; PIB / MHI PM E-DRIVE CLOSURE NOTICE.

INVESTOR QUESTION: WHAT EXACTLY WILL H2ONE SELL?

DAFC-10 is an integrated DC power system designed around an existing electric drivetrain.



PARAMETER	DAFC-10 (TARGET SYSTEM)	STATUS
net DC output	10.0 kW	●
gross stack output	12.0 kW	●
preliminary cell count	149	●
active area / cell	900 cm ²	●
cell dimension	30 × 30 cm	●
rated stack voltage	≈55 V	●
rated current	≈219 A	●
rated cell voltage	≈0.369 V	●
rated current density	≈0.243 A/cm ²	●
estimated OCV	≈126.7 V	●
BoP electrical load	≈1.54 kW	●
DC/DC allowance	≈0.46 kW	●
membrane tested (POC)	20 μm PiperION	●
vehicle membrane candidate	80 μm PiperION	●
NH ₃ inventory	10 kg	●
nominal vessel volume	≈20 L	●
transient buffer	≈100 Wh / 6 kW	●

149 cells is the current central-case system-model estimate. Final cell count and rated V-I point will be frozen after the 900 cm² single-cell test.

H2ONE SUPPLIES

stack • BoP • DC/DC • buffer • ECU •
NH₃ system • safety • service

OEM RETAINS

PMSM • traction inverter •
chassis • body • brakes

One power module for OEM integration; one controlled fuel-and-service system for fleets.

Source: H2ONE system model (Sept 2026) and internal engineering design. See appendix for assumptions and status definitions.

INVESTOR QUESTION: WHY USE AMMONIA AS THE ENERGY CARRIER?

Ammonia combines carbon-free chemistry at the point of use with liquid-fuel-like storage.



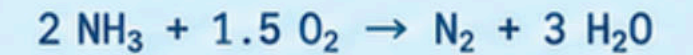
KEY PROPERTIES OF AMMONIA • REFERENCE

				
17.6 – 17.8 wt% H (by mass)	18.6 MJ/kg LHV	≈5.17 kWh/kg LHV	–33.4 °C boiling point at 1 atm	≈8 – 10 bar vapour pressure at 20 – 25 °C

ENERGY CARRIER COMPARISON • REFERENCE

Carrier	Typical onboard state	Approx. specific energy (kWh/kg)	Carbon in molecule
 Li-ion battery	battery pack	~0.15 – 0.25 (kWh/kg pack)	—
 H ₂	350 – 700 bar (compressed gas)	33.3 (fuel)	none
 CNG	~200 bar (compressed gas)	~13.9 (fuel)	yes
 NH ₃	moderate-pressure liquid (–33 °C or ~8.6 bar at 20 °C)	5.17 (fuel)	none

DAFC CHEMISTRY • REFERENCE



Theoretical voltage (ΔG):	≈1.17 V
LHV-equivalent voltage:	≈1.09 V

KEY TRADE-OFFS

-  Toxic → engineered containment required.
-  Lower source-to-wheel efficiency than direct battery charging.
-  No dedicated Indian NH₃ road-vehicle standard yet.

CARBON HONESTY • REFERENCE

-  Conventional ammonia is carbon-intensive upstream. H2ONE's long-term climate case therefore depends on green or verifiably low-carbon ammonia.



H2ONE is testing whether storage density, rapid depot refuelling and direct conversion create a better operating system for high-utilisation fleets.

Sources: Ammonia properties – CRC Handbook, NREL; energy densities – literature values; Indian ammonia infrastructure – CEEW (2025), Deloitte/IGEF (2023), SECI/PIB (2025). See appendix for details.

INVESTOR QUESTION: DO YOU HAVE TO INVENT AN AMMONIA SUPPLY CHAIN?

No. Industrial ammonia already moves through Tamil Nadu; mobility adds a controlled last mile.



KEY SUPPLY INFRASTRUCTURE IN TAMIL NADU • REFERENCE

	Madras Fertilizers, Manali / Chennai Original ammonia capacity: 750 t/day (247,500 tpa)	●
	Coromandel, Ennore Ammonia storage tank: 12,500 MT	●
	VOC Port, Thoothukudi Liquid-ammonia handling (FY2024–25): ≈1.45 lakh tonnes	●
	AM Green, Thoothukudi (near VOC Port) Green-ammonia production facility: 1 MTPA proposed	●

Bunkering target:
200 ktpa by 2029–30
500 ktpa by 2035

CONTROLLED PILOT SUPPLY FLOW • CONCEPT FOR INITIAL FLEETS



GREEN AMMONIA PRICE REFERENCE • REFERENCE

	SECI green-ammonia auction (2025) ₹49.75 → ₹64.74/kg
	Madras Fertilizers, Chennai ₹50.00/kg 4,000 tpa (green ammonia)

WHY THIS MATTERS

- ✓ Large existing industrial supply base.
- ✓ Ports and producers expanding green-ammonia capacity.
- ✓ Enables controlled depot-based supply for initial pilots.
- ✓ No public roadside network required in Phase 1.



Phase 1 does not require a public roadside ammonia network.

INVESTOR QUESTION: WHY NOT CRACK NH_3 TO H_2 FIRST?

H2ONE removes the external cracker and purifier from a small-vehicle powertrain.

ROUTE A NH_3 CRACKER + H_2 CLEANUP + H_2 FUEL CELL (CONVENTIONAL PATH)



ROUTE B H2ONE DIRECT AEM-DAFC (OUR APPROACH)



TECHNOLOGY COMPARISON • REFERENCE

Route	Temperature	Extra hardware	Mobility implication
cracker + PEMFC	high-temp cracking + $\sim 80^\circ\text{C}$ FC	cracker + cleanup	heat-up, volume, controls
direct SOFC	generally $> 500^\circ\text{C}$	hot-box / insulation	slow thermal cycling
H2ONE AEM-DAFC	$\approx 70^\circ\text{C}$ tested	no external H_2 cracker	low-temperature direct route



COMPETITOR EXAMPLES • REFERENCE



Amogy • REFERENCE
1 MW pilot planned for 2026 in Pohang, with scale-up plans to 40 MW commercial operations in 2028–2029. Technology uses ammonia cracking to hydrogen before power generation.



Hyamtec Hy-5 • REFERENCE
Portable/containerised ammonia cracking module producing up to 500 kg H_2 /day.

BALANCED VIEW



Direct AEM-DAFC power density remains below mature hydrogen PEMFC stacks. H2ONE is testing whether system simplicity wins at ~ 10 kW vehicle scale.

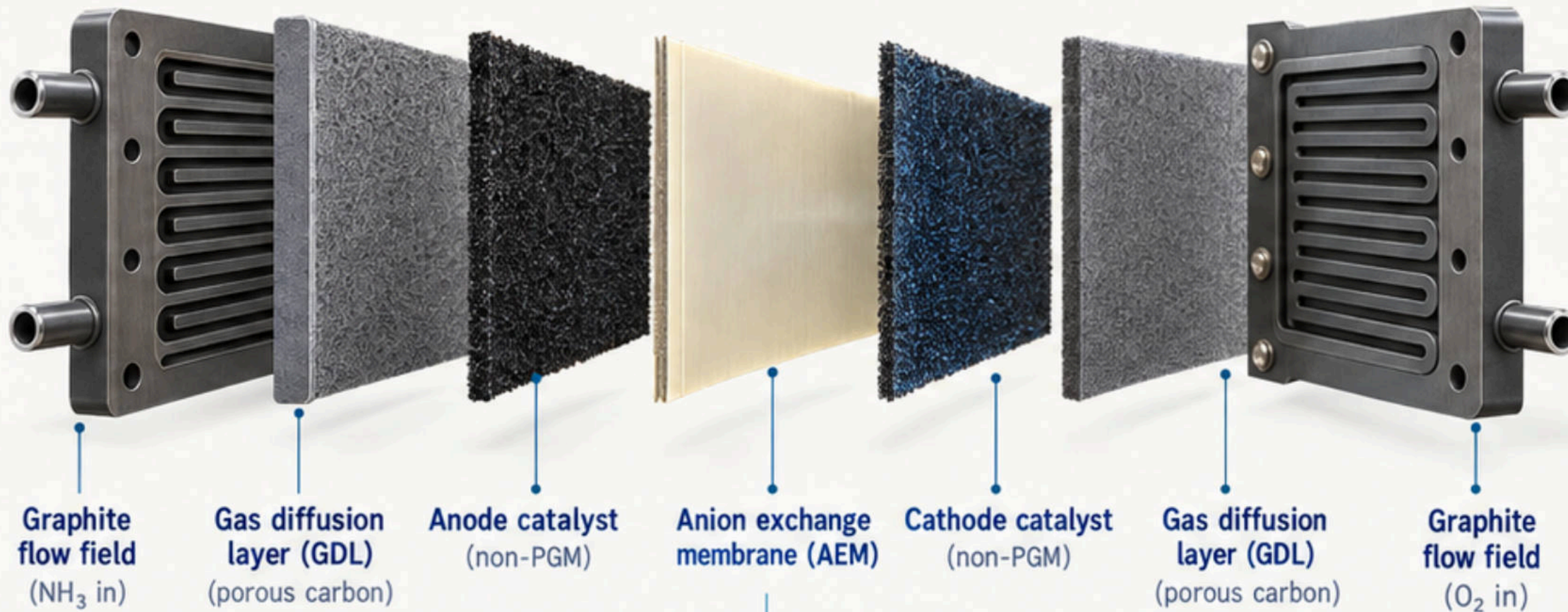
 At vehicle scale, H2ONE is testing whether removing the cracker-and-cleanup subsystem can reduce thermal, packaging and control complexity.

Sources: Amogy public announcements (2024–2025); Hyamtec product information; ammonia cracking technology literature. See appendix for details.

INVESTOR QUESTION: WHAT IS ACTUALLY DIFFERENT INSIDE THE CELL?

A gas-fed, non-PGM AEM cell operating at $\approx 70^\circ\text{C}$.

EXPLODED VIEW OF H2ONE DIRECT AMMONIA FUEL CELL (DAFC)



20 μm TESTED

80 μm VEHICLE CANDIDATE

(Membrane thickness scaled for durability and lower crossover)

i 80 μm is a development candidate to be validated for crossover, resistance and water balance; it is not yet a proven optimum.

MEASURED CONFIGURATION

anode	non-PGM catalyst
membrane	PiperION 20 μm
cathode	non-PGM catalyst
anode feed	NH_3 gas
cathode feed	O_2 gas
added liquid electrolyte	none
temperature	$\approx 70^\circ\text{C}$
active area	25 cm^2
peak	121 mW/cm^2

ELECTROCHEMISTRY

Anode (oxidation)	$2\text{NH}_3 + 6\text{OH}^- \rightarrow \text{N}_2 + 6\text{H}_2\text{O} + 6\text{e}^-$
Cathode (reduction)	$1.5\text{O}_2 + 3\text{H}_2\text{O} + 6\text{e}^- \rightarrow 6\text{OH}^-$
Overall reaction	$2\text{NH}_3 + 1.5\text{O}_2 \rightarrow \text{N}_2 + 3\text{H}_2\text{O}$

FIVE TECHNICAL RISKS

- 1 air vs O_2 performance
- 2 NH_3 crossover
- 3 water balance
- 4 CO_2 / carbonate effects on air
- 5 catalyst and membrane durability

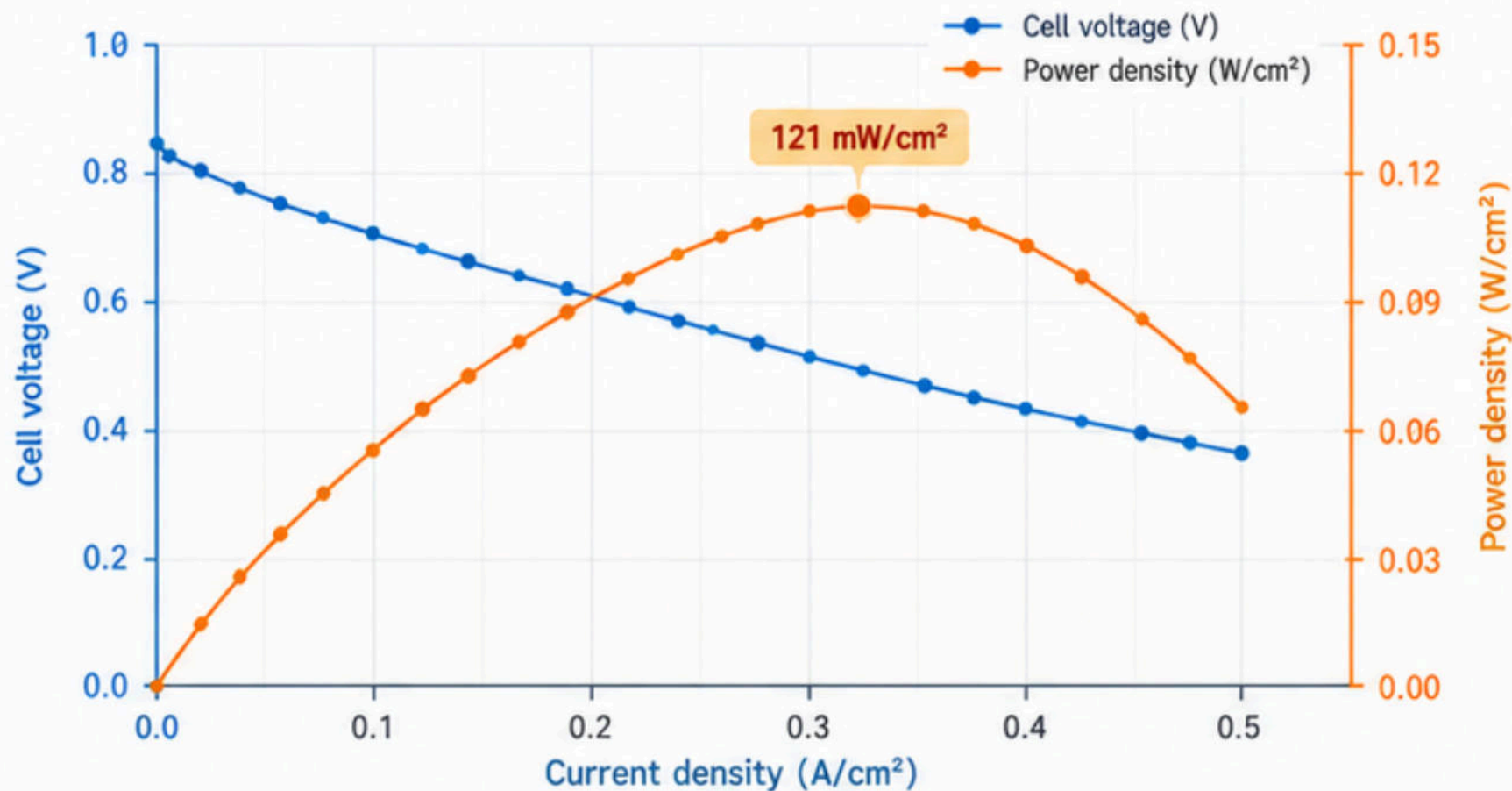
H2ONE's differentiation begins at the cell: direct NH_3 feed, no added liquid electrolyte, and a non-PGM low-temperature AEM architecture.

Sources: H2ONE internal test data (2024–2026). Configuration and performance are for 25 cm^2 single cell under controlled conditions. 80 μm membrane is a development candidate subject to further validation.

INVESTOR QUESTION: HOW DOES H2ONE COMPARE WITH PUBLISHED DAFC WORK?

121 mW/cm² places H2ONE in the low-temperature DAFC literature range — with a gas-fed, non-PGM configuration.

H2ONE 25 cm² SINGLE-CELL PERFORMANCE • EXPERIMENTAL • H2ONE 2026



Active area	Temperature	Anode	Membrane	Cathode	Liquid electrolyte	Peak power density
25 cm ²	≈70 °C	NH ₃ gas (non-PGM)	PiperION 20 μm	O ₂ gas (non-PGM)	None	121 mW/cm ²

LITERATURE BENCHMARK COMPARISON • REFERENCE

Work / Year	Configuration (key details)	Temperature	Peak power density (mW/cm ²)	
H2ONE 2026 (Experimental)	non-PGM both electrodes • NH ₃ gas • no added liquid electrolyte • O ₂ • 25 cm ²	≈70 °C	121	EXPERIMENTAL
Zhao et al., Joule 2019	ammonia-tolerant precious-metal-free cathode / DAFC prototype	80 °C	135	REFERENCE
Wang et al., Cell Reports Physical Science 2022	hydrophobic spinel cathode; high-performance DAFC (five 50 cm ² cells → 75 W stack; continuous 80 h at 300 mA/cm ²)	90–110 °C	410	REFERENCE
Wu et al., Advanced Energy Materials 2026	integrated non-noble Ni ₃ P anode (>320 h catalyst durability)	published conditions	166.83 (O ₂) 123.69 (air)	REFERENCE
Int. J. Hydrogen Energy 2026	11 M NH ₃ + 1 M KOH	120 °C	585.5	REFERENCE



H2ONE's result is competitive with several published low-temperature DAFC demonstrations while using a larger 25 cm² active area and a non-PGM, gas-fed configuration without added liquid electrolyte.

Conditions differ across studies; peak power density alone is not a like-for-like system comparison.



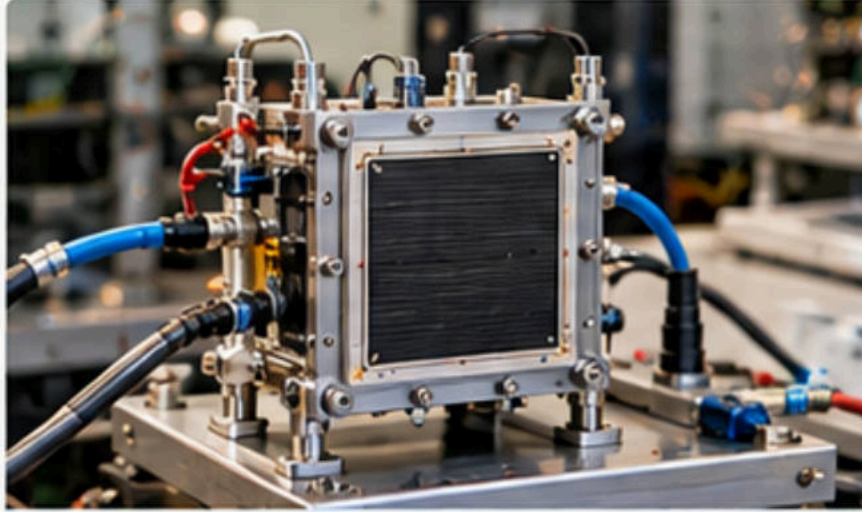
Benchmarking shows credible lab performance; the next proof point is retaining performance as active area scales.

Sources: H2ONE internal test data (2026); Zhao et al., Joule 2019; Wang et al., Cell Reports Physical Science 2022; Wu et al., Advanced Energy Materials 2026; International Journal of Hydrogen Energy 2026.

INVESTOR QUESTION: HOW DO YOU SCALE A 25 cm² CELL INTO A 10 kW SYSTEM?

Prove area retention first. Then multiply validated cells.

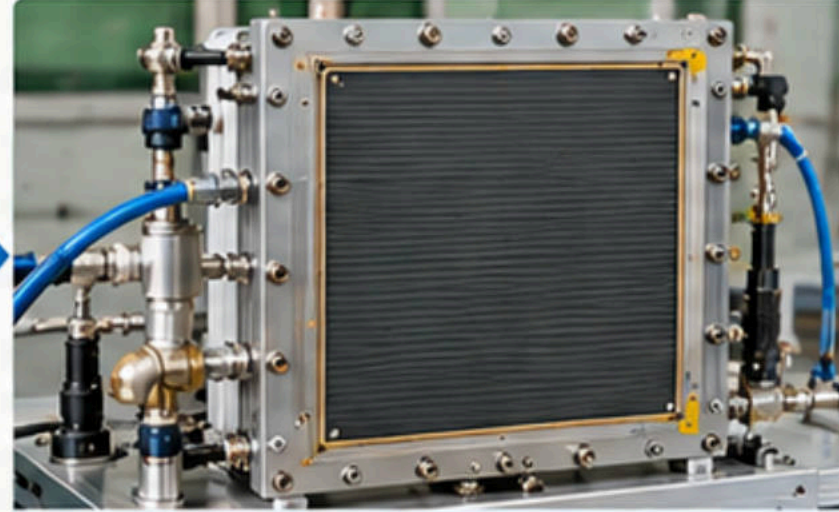
GATE 1 25 cm² + COMPLETE BoP EXPERIMENTAL



- air operation
- NH₃ utilisation
- water balance
- crossover
- durability

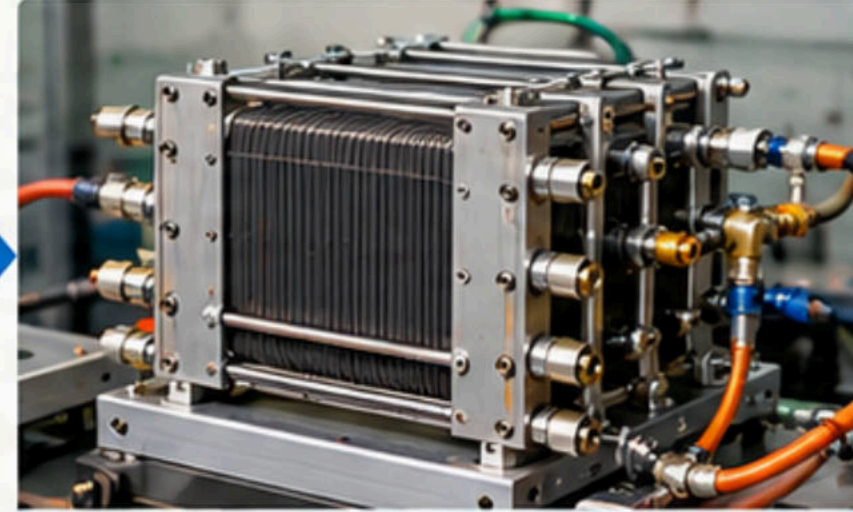
25 cm² measured cell: 121 mW/cm² (≈70 °C)

GATE 2 900 cm² SINGLE CELL IN DEVELOPMENT



- 30 × 30 cm (900 cm²)
- 80 μm membrane candidate
- flow distribution
- thermal map
- performance retention

GATE 3 10-CELL SHORT STACK IN DEVELOPMENT



- cell-voltage spread
- manifold balance
- compression
- leakage
- thermal consistency

GATE 4 DAFC-10 (VEHICLE STACK) TARGET



- central estimate ~149 cells
- 12 kW gross
- 10 kW net
- vehicle integration

RATED-POINT SCALING (PER CELL) • FROM CURRENT SYSTEM MODEL

Parameter	25 cm ² equivalent	900 cm ² cell (30 × 30 cm)
Current density	≈0.243 A/cm ²	≈0.243 A/cm ²
Current	≈6.08 A	≈219 A
Cell voltage	≈0.369 V	≈0.369 V
Cell power	≈2.24 W	≈80.5 W
Stoich. NH ₃ (4 e ⁻ /NH ₃)	≈1.29 g/h	≈46.4 g/h
Stoich. air (3/4 O ₂)	≈0.101 NL/min	≈3.64 NL/min

RETENTION SENSITIVITY • IMPACT ON STACK SIZE AND RANGE

Area retention (at rated point)	Estimated cell count	Gross stack power	Net stack power	Estimated urban range (10 kg NH ₃)
100%	114	≈11.4 kW	≈10 kW	≈228 km
80%	149	≈12.0 kW	≈10 kW	≈178 km
60%	216	≈17.4 kW	≈10 kW	≈128 km

Central model: 149 cells × ≈80.5 W ≈ 12.0 kW gross.
Final cell count and rated V-I point will be frozen after the 900 cm² single-cell test.

STACK TARGET (DAFC-10) • CENTRAL CASE

Cells (estimated)	~149
Cell active area	900 cm ² (30 × 30 cm)
Gross stack output	12.0 kW
Net DC output	10.0 kW
Rated stack voltage	≈55 V
Rated current	≈219 A
Rated cell voltage	≈0.369 V



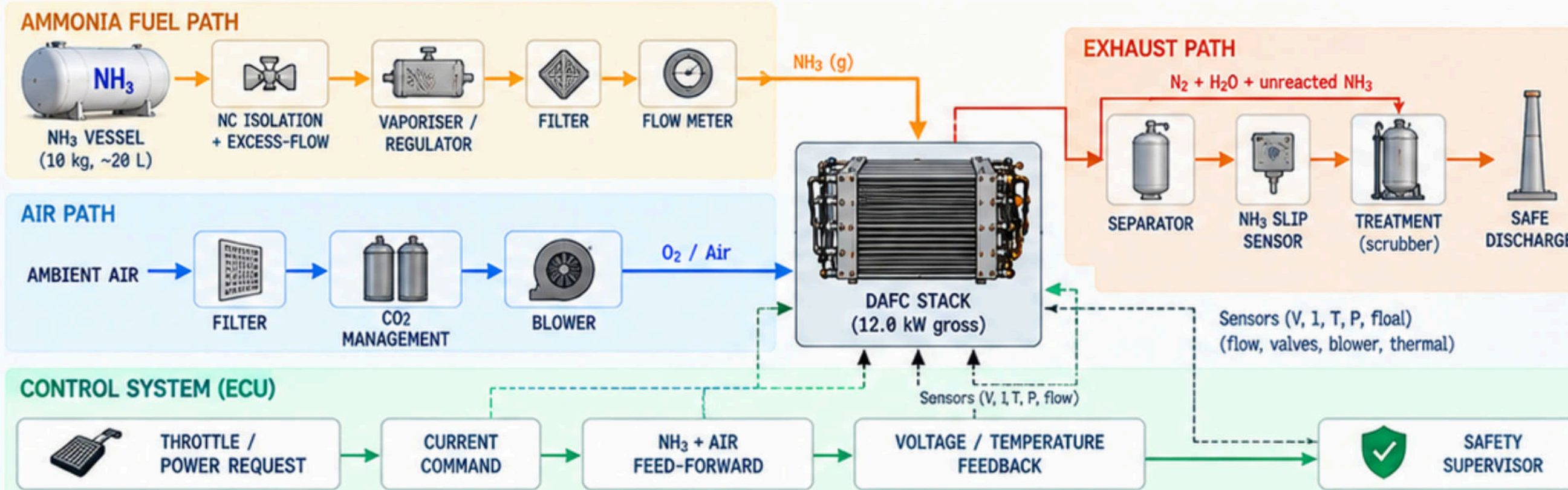
The 900 cm² gate determines the final stack count, cost, thermal load and vehicle range.

Source: H2ONE system model (Sept 2026) and internal engineering design. See appendix for assumptions and status definitions.

INVESTOR QUESTION: IS THIS A CELL PROJECT OR A COMPLETE AUTOMOTIVE POWER SYSTEM?

The stack is one subsystem; DAFC-10 is the controlled automotive energy system.

SYSTEM ARCHITECTURE (MATLAB / SIMULINK TOP-LEVEL MODEL)



KEY SYSTEM NUMBERS • FROM SYSTEM MODEL

Gross stack output	12.0 kW	●
BoP electrical load	1.54 kW	●
DC/DC allowance	0.46 kW	●
Net DC output (system objective)	10.0 kW	●

REACTANT FLOW (RATED) • FROM SYSTEM MODEL

Theoretical NH ₃ consumption	6.91 kg/h	●
Feed at 75% utilisation	9.21 kg/h	●
Air flow ($\lambda = 1.5$)	814 NL/min	●

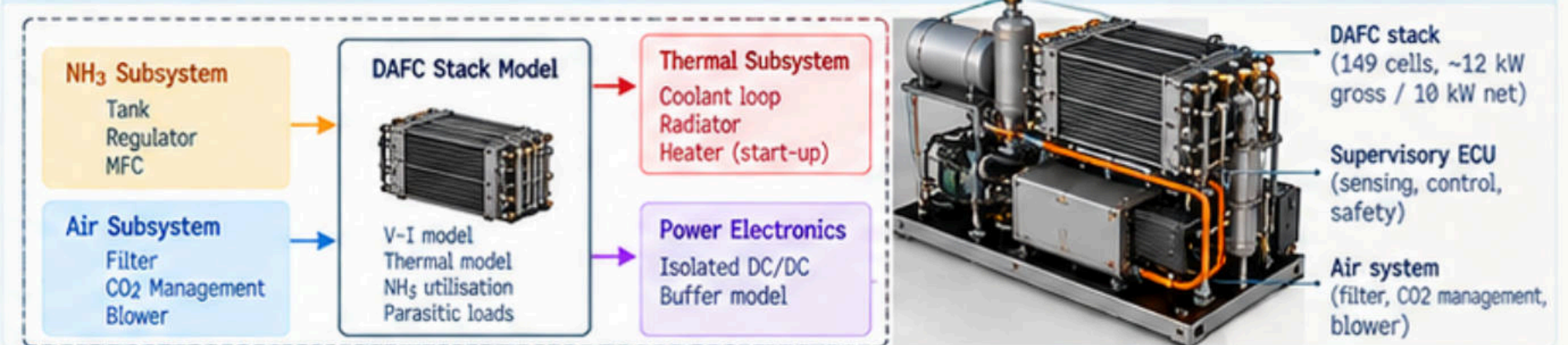
THERMAL MANAGEMENT • FROM SYSTEM MODEL

Stack reaction / thermal rejection	≈24 kW	●
Cooling-loop engineering capacity	≈30 kW	●

POWER FLOW (VEHICLE INTEGRATION)



STACK + BoP MODEL (MATLAB / SIMULINK)



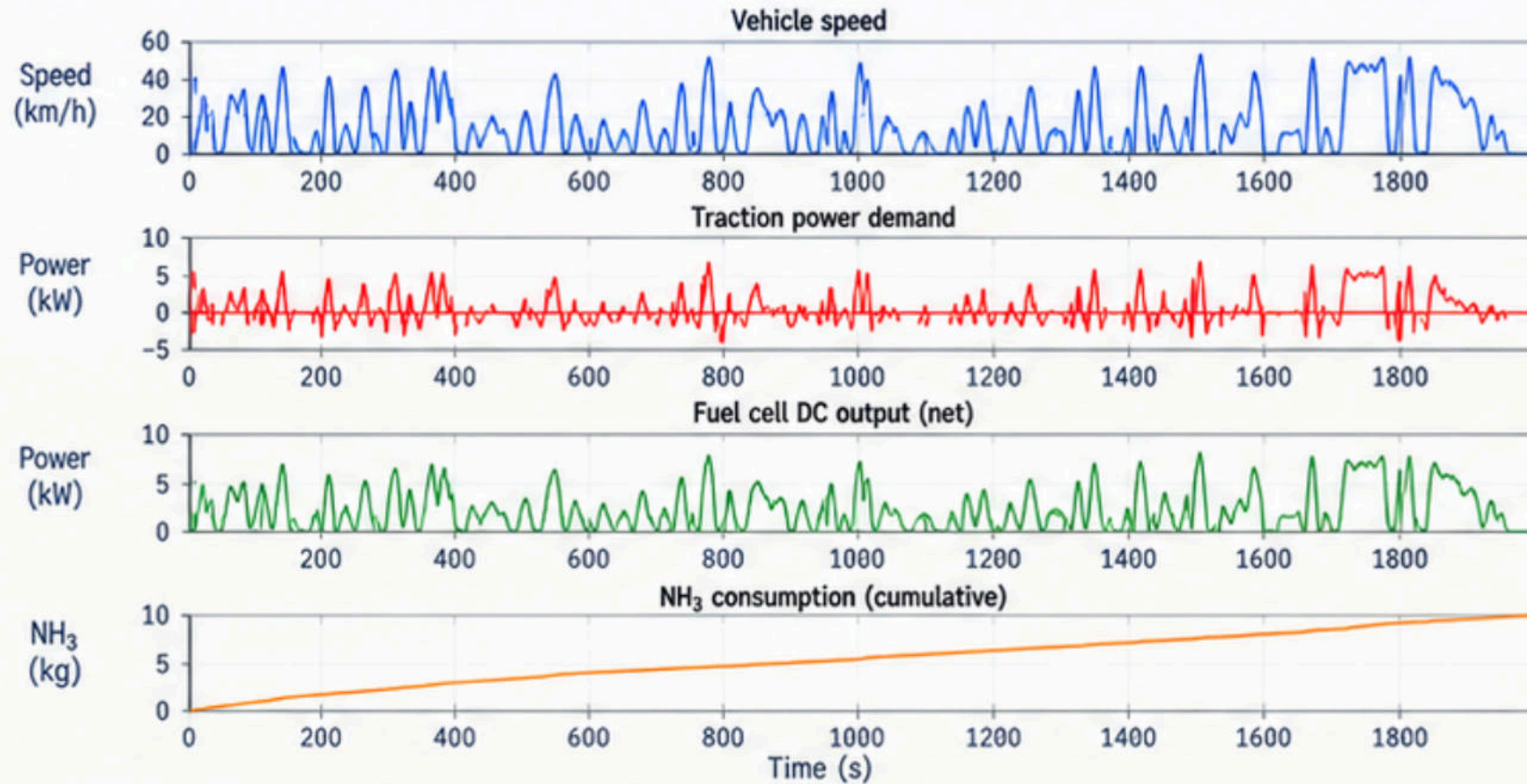
 Air operation, parasitic power, utilisation and thermal rejection are validation gates — not assumed solved.

INVESTOR QUESTION: WHAT DOES THE CURRENT MODEL PREDICT?

Central-case model: ≈ 178 km urban range today; ≈ 247 km at the 40% efficiency target.

VEHICLE SIMULATION (MATLAB / SIMULINK) • SYNTHETIC URBAN CYCLE OUTPUT

SIMULATED



SIMULATION RESULTS • FROM SYSTEM MODEL (11_System_Model)

SIMULATED

Duty	Net efficiency (NH ₃ LHV → DC)	NH ₃ consumption (kg / 100 km)	10 kg range (km)
Synthetic urban cycle	28.8%	5.63	≈ 178
30 km/h (steady)	31.1%	3.85	≈ 260
40 km/h (steady)	32.9%	4.19	≈ 238
55 km/h (steady)	32.8%	5.38	≈ 186
12° climb @ 15 km/h	27.0%	—	buffer peak ≈ 6 kW

TARGET CASE (40% NET EFFICIENCY)

TARGET

Net efficiency (NH ₃ LHV → DC)	NH ₃ consumption (kg / 100 km)	10 kg range (km)
40%	≈ 4.05	≈ 247

MODEL INTEGRITY

SIMULATED

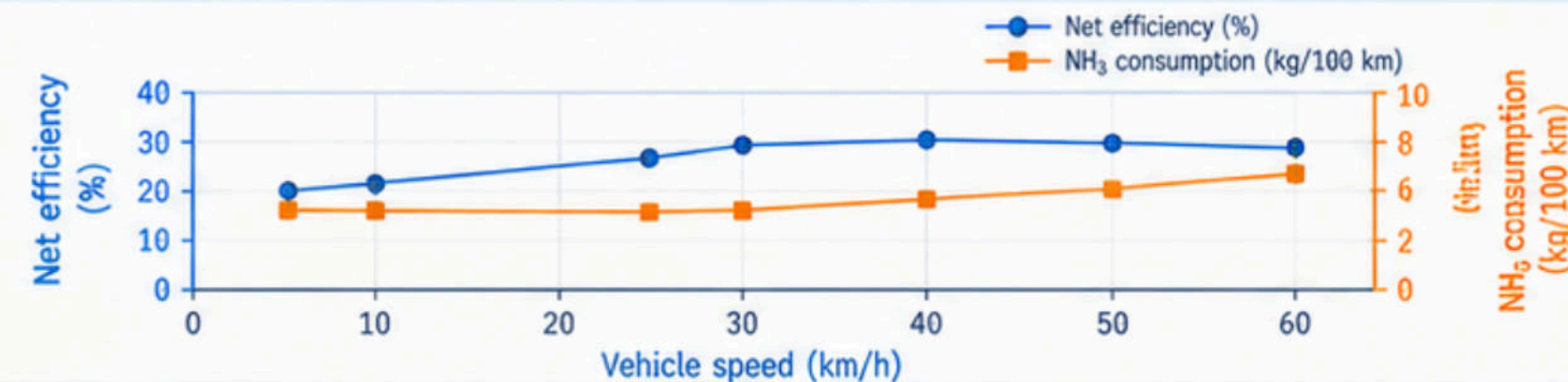
MATLAB ↔ Simulink difference **$< 0.4\%$**

SENSITIVITY (URBAN RANGE)

SIMULATED

$\approx 96 - 273$ km
across model sensitivity envelope

EFFICIENCY vs VEHICLE LOAD • FROM SYSTEM MODEL



KEY TAKEAWAYS

-  ≈ 178 km urban range on 10 kg NH₃ (28.8% net efficiency).
-  At 40% net efficiency → ≈ 247 km / 10 kg (target).
-  Steady-speed range: **260 km** (30 km/h) → 186 km (55 km/h).
-  12° climb requires transient buffer (≈ 6 kW).

! MODEL LIMITATIONS

- Synthetic urban cycle (not real-world drive data).
- Measured cell uses O₂, vehicle uses air.
- Stack performance retention is assumed until 900 cm² single-cell test.
- NH₃ utilisation is assumed.
- Crossover, water balance and BoP maps require measurement.

 The current model shows credible range and efficiency. Final performance depends on 900 cm² cell validation and measured BoP maps.

Source: H2ONE system model (11_System_Model, Sept 2026).

INVESTOR QUESTION: DOES THE SYSTEM FIT WITHOUT REINVENTING THE VEHICLE?

Keep the electric drivetrain. Replace the energy-storage architecture.

REFERENCE L5 THREE-WHEELER (UNBRANDED)



REFERENCE VEHICLE (BASE PLATFORM)

Gross vehicle weight (GVW)	791 kg
Top speed	55 km/h
Gradeability	12°
PMSM (peak)	10 kW
Peak torque	60 Nm
Original battery (Li-ion)	10.6 kWh

VEHICLE INTEGRATION — SYSTEM LAYOUT (CUTAWAY VIEW)

● H2ONE supply ● Retained from OEM ● Safety critical [critical]



VEHICLE PHYSICS (FROM SIMULATION)

SIMULATED

Speed (flat road)	Steady DC-bus power
30 km/h	1.74 kW
40 km/h	2.73 kW
55 km/h	4.89 kW

10 kW SUSTAINED-SPEED MODEL

SIMULATED

Grade	Maximum speed
0° (flat)	55 km/h
6°	30.9 km/h
12°	17.4 km/h

ELECTRICAL SAFETY

Estimated stack OCV ≈126.7 V DC

Target architecture includes:

- HVIL (high-voltage interlock loop)
- Isolation monitoring
- Guarded connectors
- Service disconnect
- Orange HV cable
- Contactors / pre-charge

DRIVETRAIN: KEEP vs CHANGE

KEEP (FROM OEM)

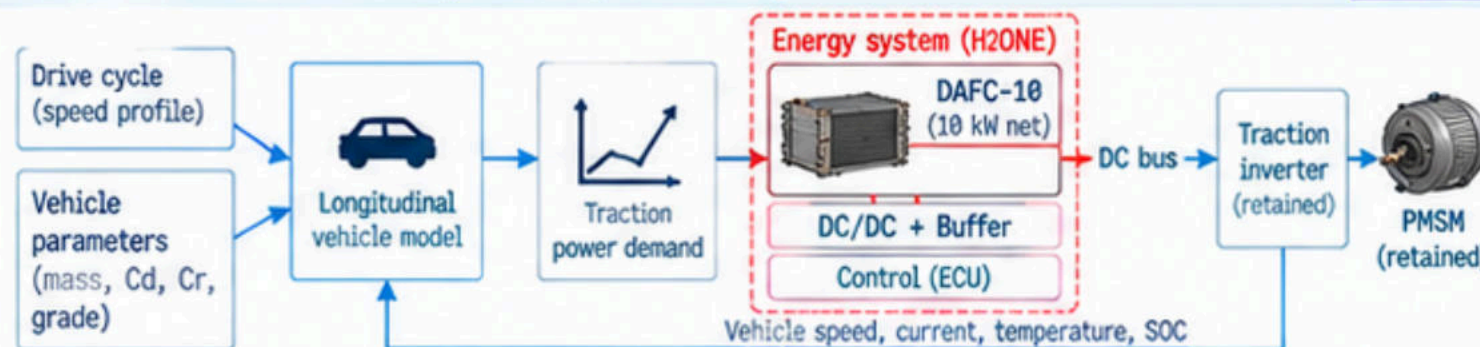
- ✓ Chassis and body
- ✓ PMSM (10 kW)
- ✓ Traction inverter
- ✓ Braking system
- ✓ Suspension and steering
- ✓ Vehicle control systems (as applicable)

CHANGE (H2ONE SUPPLY)

- ✚ DAFC-10 stack (10 kW net, 12 kW gross)
- ✚ NH₃ tank (10 kg / ~20 L)
- ✚ Balance of Plant (BoP)
- ✚ Isolated DC/DC
- ✚ Transient buffer (~100 Wh / 6 kW)
- ✚ Supervisory ECU (control & safety)
- ✚ Safety systems (sensors, ventilation, shutdown)

VEHICLE E-DRIVE MODEL (MATLAB / SIMULINK)

SIMULATED



The system fits within the existing vehicle architecture, replacing only the energy-storage components.

INVESTOR QUESTION:

AMMONIA IS TOXIC — WHAT PREVENTS A RELEASE FROM REACHING OCCUPANTS?

Contain first. Detect early. Isolate in hardware. Vent away from occupants.



AMMONIA HAZARD REFERENCE VALUES • SOURCE: NIOSH / CDC

NIOSH REL	NIOSH STEL	OSHA PEL	IDLH	LEL (air)
25 ppm TWA	35 ppm	50 ppm TWA	300 ppm	~15 vol%

1 CONTAIN



- 10 kg inventory (~20 L vessel)
- Sealed under-seat enclosure
- Excess-flow valve
- Normally-closed fuel solenoid
- Service valve
- Pressure-relief device

2 DETECT + ISOLATE



- Enclosure NH₃ sensor
- Rear-bay sensor
- Cabin backstop sensor
- Crash / tilt switch
- Manual external shut-off
- Hardware fuel cut (independent of software)

Preliminary thresholds

- ⚠ 20 ppm → Warning
- ⚠ 30 ppm → Automatic isolation

3 VENT + SAFE STATE



- Negative-pressure enclosure
- Forced extraction
- Adsorbent treatment (scrubber / trap)
- Rearward floor discharge
- Controlled safe-state sequence

Preliminary engineering values subject to HAZOP, sensor validation and homologation review.

AUTOMATIC SAFETY SEQUENCE



 DRIVER INSTRUCTION (IN EVENT OF ALARM)

Stop safely, key off, move occupants upwind, keep clear and contact fleet control / emergency services.



Safety is designed in from the system level — containment, detection, isolation and ventilation.

INVESTOR QUESTION: IS THERE AN EXISTING TYPE-APPROVAL STANDARD FOR NH₃ ROAD VEHICLES?

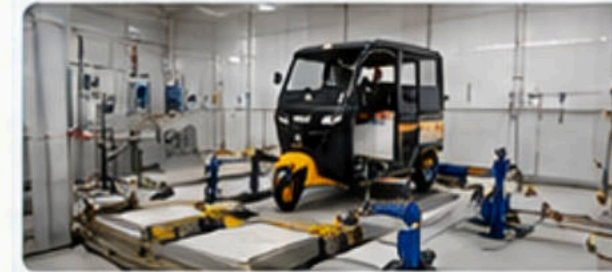
India has EV and hydrogen-FCV safety frameworks — but no dedicated ammonia-road-vehicle standard yet.

Area	Reference / Standard	Key scope (relevant to H2ONE)	H2ONE use
L5 vehicle type approval	CMVR (Central Motor Vehicles Rules)	Three-wheeler (L5) type approval via authorised test agency	Base vehicle (chassis, body, braking, etc.)
2W/3W REESS safety	AIS-156 Part 2	Rechargeable Energy Storage System (REESS) for electric vehicles	Guidance for buffer battery
Hydrogen-FCV precedent	AIS-157	Safety requirements for compressed gaseous hydrogen fuel cell vehicles	Safety-case structure only (not directly applicable to NH ₃)
Electrical safety	ISO 6469-3	Electrical safety for electric road vehicles (protection against electric shock)	Reference for >60 V DC systems
FC module safety	IEC 62282-2-100	Fuel cell power modules — safety	Module-level safety reference
Industrial FC propulsion	IEC 62282-4-101	Fuel cell power systems for industrial applications — safety test methods	Test-method reference only (not a road-vehicle type-approval standard)
Storage / depot	PESO + applicable rules	Pressure vessel and gas storage regulations (for ammonia storage)	NH ₃ storage (vessel, fittings, depot)
Toxic-gas detection	Applicable industrial standards (e.g., IEC / IS)	Fixed and portable toxic-gas detectors	NH ₃ sensing (enclosure, cabin, depot)

INDIAN AUTOMOTIVE TESTING INFRASTRUCTURE



ARAI (Automotive Research Association of India) – Pune
India's authorised automotive testing and homologation agency



Chassis and emission testing facility
(Source: ARAI public information)

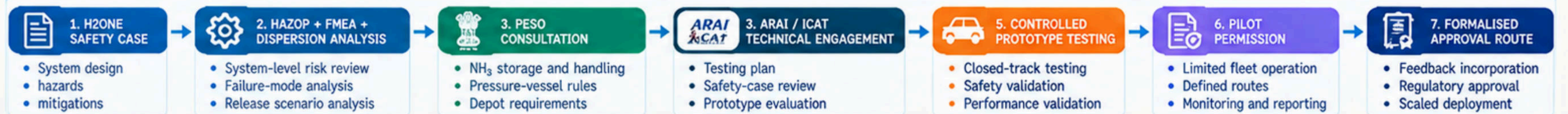


Environmental and safety testing
(Source: ARAI public information)

- Important:**
- AIS-157 is specifically for compressed gaseous hydrogen FCVs. It is not an ammonia standard.
 - IEC 62282-4-101 is not a road-vehicle type-approval standard. It provides test methods for industrial fuel cell systems.

- These standards act as references and templates.
- A dedicated ammonia-road-vehicle homologation pathway does not yet exist in India.

DEVELOPMENT AND APPROVAL ROUTE (PROPOSED)



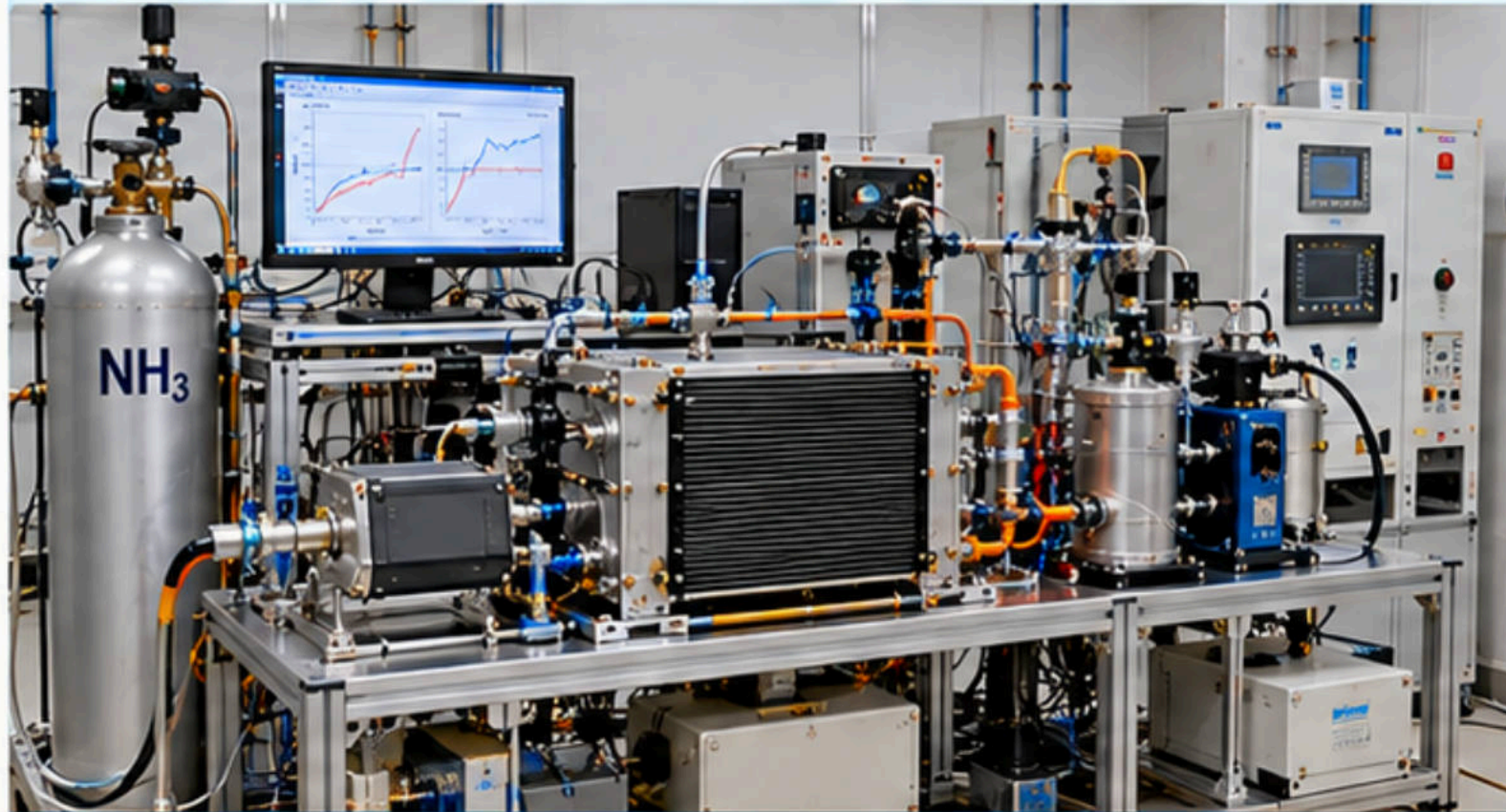
We will follow an engineering-led regulatory pathway using existing Indian standards and early engagement with PESO, ARAI and ICAT.

Source: CMVR; AIS-166; AIS-157; ISO 6469-3; IEC 62282-2-100; IEC 62282-4-101; PESO; ARAI (public information).

INVESTOR QUESTION: WHAT HAS TO BE TRUE BEFORE A VEHICLE PILOT?

Every scale-up stage has a measurable pass/fail gate.

H2ONE FUEL-CELL TEST LAB (EXPERIMENTAL SETUP)

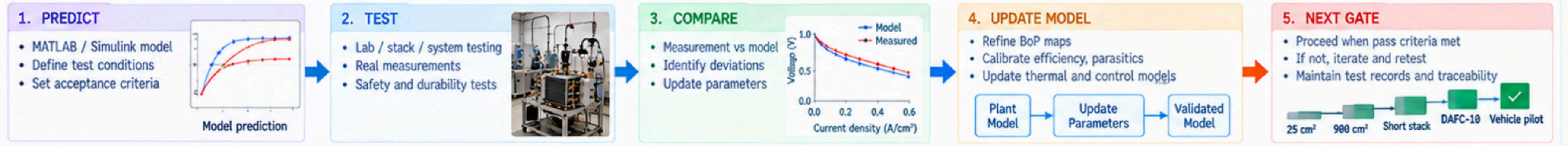


25 cm² DAFC test setup with complete BoP, instrumentation and control (H2ONE lab)

TEST + VALIDATION MATRIX • FROM LAB CELL TO VEHICLE PILOT

Gate	Key tests / activities	Pass criterion (target)
1. 25 cm ² BoP	Air operation, NH ₃ utilisation, crossover, water balance, closed-loop control	Stable closed-loop operation
2. 25 cm ² durability	Constant-current operation, start/stop cycles, performance tracking	≥500 h programme
3. 900 cm ² single cell	Polarization, EIS, thermal map, flow distribution, scaling behaviour	≥80% retention target
4. Short stack (10 cells)	Cell-voltage spread, ΔP, leak test, temperature uniformity, manifold balance	Cell σ < 15 mV target
5. DAFC-10 (system)	Gross/net output, transient response, parasitic power, efficiency maps	12 kW gross / 10 kW net
6. Exhaust treatment	NH ₃ slip measurement after separator and treatment	< 25 ppm target
7. Fuel isolation	Fault injection (sensor fail, leak, crash/tilt), isolation time measurement	< 2 s target
8. Fuel enclosure	Vibration, pressure cycle, leak test, negative-pressure hold, sensor function	No hazardous cabin release
9. Vehicle integration	Chassis integration, dyno test, gradeability, braking, EMC, thermal management	Agreed ARAI / ICAT protocol
10. Pilot operation	5 vehicles, real-world operation, telematics monitoring, maintenance review	Zero safety events target

SIMULATION-IN-THE-LOOP VALIDATION • PREDICT → TEST → COMPARE → UPDATE → NEXT GATE

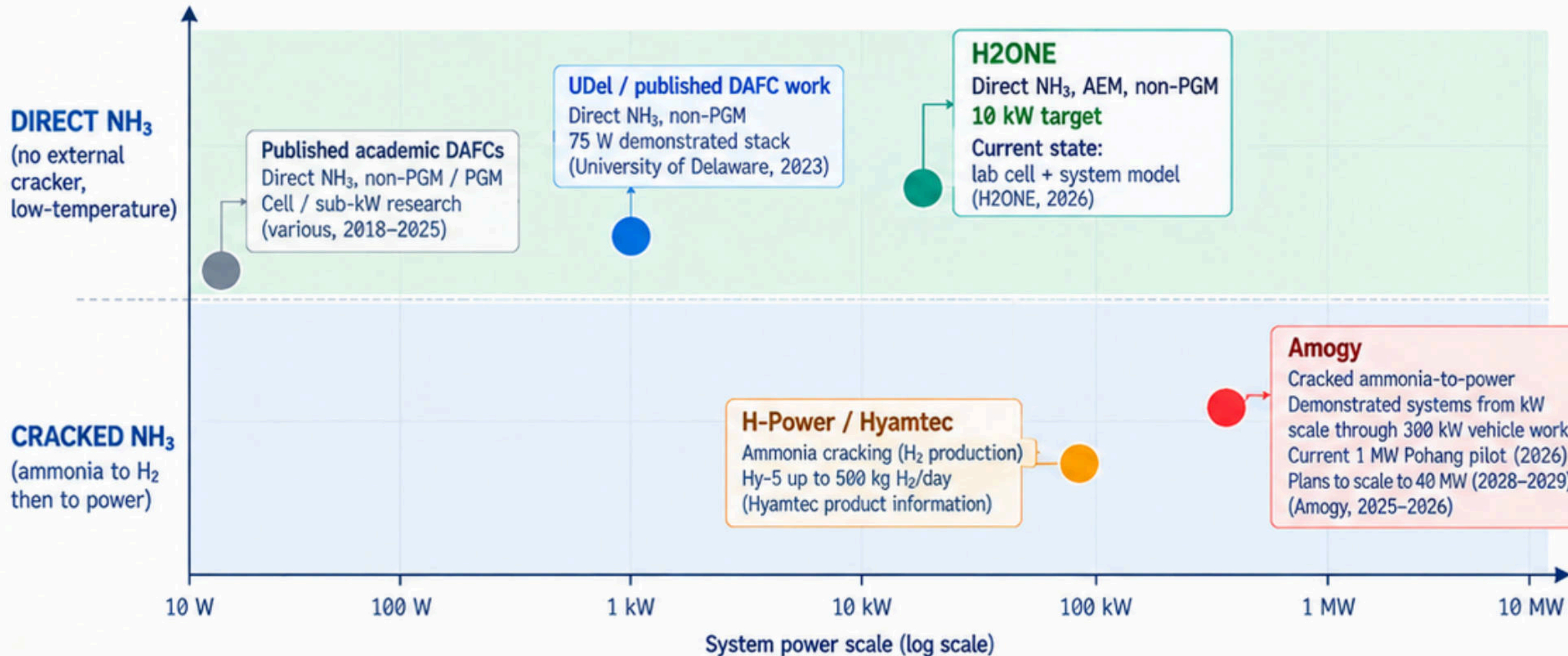


Progress to the next stage only when the defined pass/fail criteria are met with test data.

INVESTOR QUESTION: WHO ELSE IS TURNING AMMONIA INTO ELECTRICITY?

Commercial ammonia-to-power programmes mostly crack NH_3 first; direct low-temperature DAFC remains largely pre-commercial.

AMMONIA-TO-POWER POSITIONING MAP • BY CONVERSION ARCHITECTURE AND PUBLIC SCALE EVIDENCE



Positioning is by conversion architecture and public scale evidence; not a like-for-like commercial maturity ranking.

REAL DAY-ONE COMPETITORS



- BEV + charging**
- Low operating cost
 - Established infrastructure (urban)
 - Strong OEM and policy support



- Battery swapping**
- Fast refuel / short downtime
 - Growing in 3W commercial fleets
 - Backed by fleet operators and OEMs



- CNG**
- Widely available infrastructure
 - Lower upfront cost
 - Established 3W market



H2ONE differentiation: direct NH_3 conversion + low-temperature AEM + non-PGM pathway + small-vehicle integration.

INVESTOR QUESTION: WHO BUYS THE FIRST SYSTEM BEFORE PUBLIC NH₃ INFRASTRUCTURE EXISTS?

Start where fuel, vehicle and driver can all be controlled: the fleet depot.



INITIAL CUSTOMERS (CONTROLLED FLEET DEPOTS)



REVENUE ARCHITECTURE



DEPOT REFUELLING CONCEPT



Prove safe and reliable operation in controlled fleets first, then scale with OEM partners and formal approvals.

INVESTOR QUESTION: WHAT HAS TO BE TRUE FOR DAFC TO MAKE FINANCIAL SENSE?

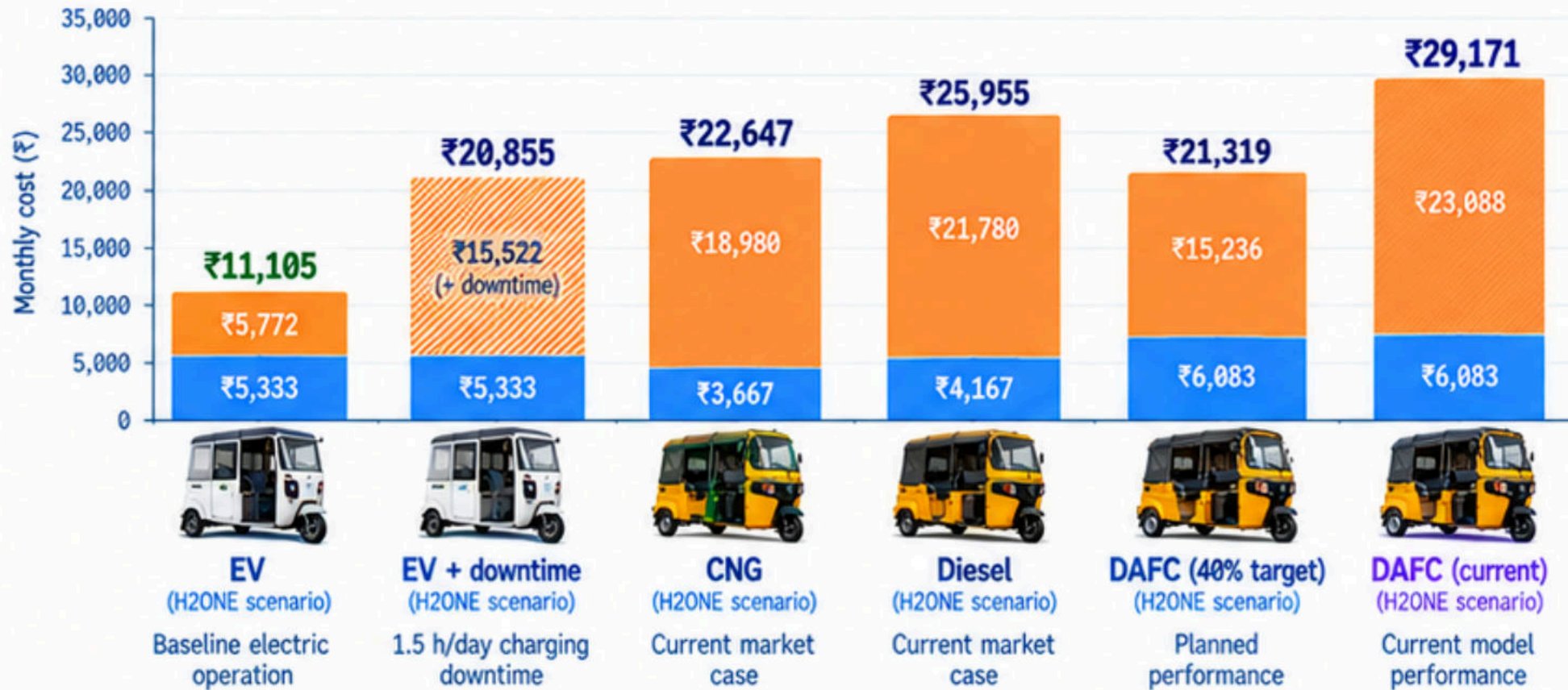
Battery EV remains cheapest on pure energy cost; DAFC must monetise uptime.

COMMON USE CASE (H2ONE SCENARIO)

A 200 km/day Vehicle usage
📅 26 days/month Operating days
📍 5,200 km/month Total distance

MONTHLY TOTAL COST COMPARISON (H2ONE SCENARIO)

Running cost/month Vehicle cost/month



KEY ASSUMPTIONS (H2ONE SCENARIO)

	CNG	Diesel	EV	DAFC (current)	DAFC (40% target)
					
Fuel price	₹97.5 / kg	₹99.55 / L	80 Wh / km	₹70 / kg (NH ₃)	₹60 / kg (NH ₃)
Efficiency	30 km / kg	27 km / L	Electricity ₹12 / kWh	5.63 kg / 100 km	4.05 kg / 100 km
Maintenance	₹0.40 / km	₹0.50 / km	₹0.15 / km	₹0.50 / km (service / refurb. reserve)	₹0.50 / km (service / refurb. reserve)
Running cost	₹3.65 / km	₹4.19 / km	₹1.11 / km	₹4.44 / km	₹2.93 / km

VEHICLE CAPITAL ASSUMPTIONS (H2ONE SCENARIO)

Parameter	CNG	Diesel	EV	DAFC (current)
Vehicle price (₹ lakh)	2.20	2.50	3.20	3.65
5-year (60 months) monthly capital (₹)	3,667	4,167	5,333	6,083

MONTHLY COST BREAKDOWN (H2ONE SCENARIO)

Case	Running cost (₹/km)	Running cost / month (₹)	Vehicle cost / month (₹)	Total / month (₹)
CNG	3.65	18,980	3,667	22,647
Diesel	4.19	21,788	4,167	25,955
EV	1.11	5,772	5,333	11,105
DAFC (current)	4.44	23,088	6,083	29,171
DAFC (40% target)	2.93	15,236	6,083	21,319

UPTIME SENSITIVITY (H2ONE SCENARIO)

EV CHARGING DOWNTIME IMPACT  1.5 h/day Charging downtime  ₹250 / h Lost contribution (per vehicle) → ₹9,750 / month Downtime cost			
Monthly total cost (₹)	EV (no downtime)	EV + 1.5 h/day downtime	DAFC (40% target)
	11,105	20,855	21,319



DAFC economics depend on technology performance and customer utilisation. It is not intended to beat a lightly used EV on electricity cost.

Source: Chennai diesel and CNG prices (Sept 2026); SECI green-ammonia auction range (2025); H2ONE model and scenario assumptions (Sept 2026).

INVESTOR QUESTION: WHAT HAPPENS WHEN THE STACK DEGRADES?

Design the stack for **exchange and refurbishment** — not vehicle scrappage.

LITERATURE REALITY (PUBLISHED DAFC WORK)

Wang et al.
Direct ammonia fuel cell (DAFC)
80 h
at 300 mA/cm²
Short-term lab demonstration (2021, 2023)

Wu et al.
Non-noble anode durability
>320 h
Improved anode durability (2022)

Current published DAFC durability remains far below automotive multi-thousand-hour service requirements.

H2ONE STACK MODULARISATION (TARGET)



STACK REFURBISHMENT (ILLUSTRATIVE)



STACK LIFE-CYCLE AND SERVICE FLOW



H2ONE DURABILITY TARGETS (NB: ALL H2ONE VALUES ARE TARGETS)

Bench programme	Pilot stack	Early production	Long-term commercial
500 h (target)	2,000 h (target)	5,000–8,000 h (target)	10,000–15,000 h (target)

SERVICE AND REFURBISHMENT ASSUMPTIONS (TARGET)

 Depot cassette exchange time < 2 h (target)	 Refurbishment cost (per event) ₹50,000– (target)
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COMPONENT REUSE AND REPLACEMENT

Reuse (after inspection)	Replace / Inspect
✓ Bipolar plates ✓ End plates ✓ Hardware (bolts, manifolds, frame) ✓ Eligible BoP components	✓ MEA (membrane-electrode assembly) ✓ Seals and gaskets ✓ Catalyst layers (anode and cathode) ✓ Membrane (PiperION, as applicable)



A serviceable, modular stack reduces lifecycle cost and keeps the vehicle in service.

INVESTOR QUESTION: WHAT BECOMES HARDER TO COPY AFTER EACH TEST?

The moat compounds through data, controls and validated safety — not only cell chemistry.

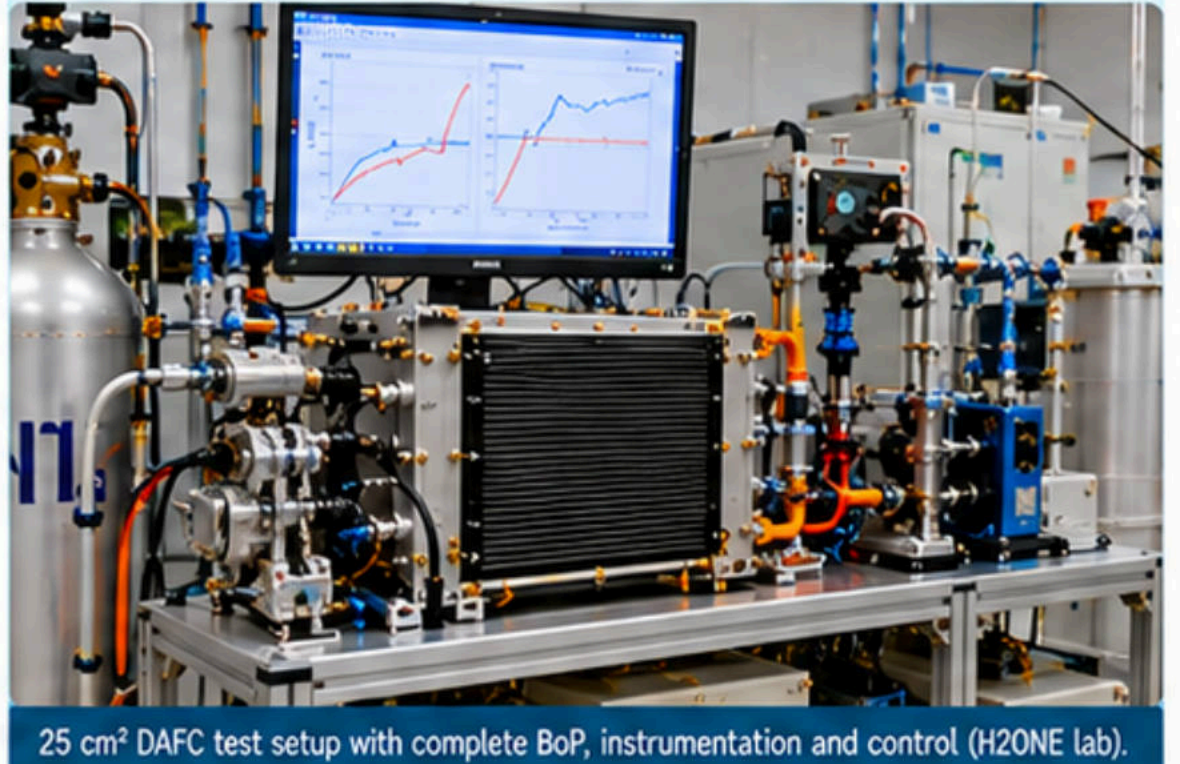
SIX LAYERS OF DEFENSIBILITY



DATA AND VALIDATION FLYWHEEL



H2ONE LAB — EXPERIMENTAL SETUP (25 cm²)



COMPETITIVE MOAT BUILDS OVER TIME



Each test generates unique data and validated know-how, making the next stage harder to replicate.

INVESTOR QUESTION: WHAT EXACTLY DOES ₹5 CRORE BUY?

₹5 crore buys the evidence required to move from a measured cell to a 10 kW vehicle demonstrator.

24-MONTH ROADMAP (KEY MILESTONES)

Work package	Key activities	M1	M2	M3	M4	M5	M6	M7	M9	M8	M10	M11	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24
1 25 cm ² BoP & durability	Complete BoP • air operation utilisation • crossover • durability starts	M1 – M4				25 cm ² BoP complete Durability programme starts																				
2 900 cm ² development	Tooling • flow-field iteration 80 µm candidate validation					M4 – M10								900 cm ² tooling complete 80 µm candidate validation												
3 900 cm ² performance gate	Polarization • EIS • thermal map target ≥80% retention													M8 – M12				900 cm ² performance gate ≥80% retention target								
4 10-cell short stack	Build • test • voltage spread ΔP • leak • temperature													M12 – M15				10-cell short stack								
5 Multi-kW stack & BoP	Stack scale-up • DC/DC • controls thermal loop																	M15 – M19				Multi-kW stack • DC/DC • controls thermal loop				
6 Vehicle integration	NH ₃ containment • safety testing power electronics																		M17 – M21				Vehicle NH ₃ containment safety testing • power electronics			
7 DAFC-10 demonstrator	10 kW net • vehicle integration controlled demonstration																				M19 – M24				DAFC-10 • 10 kW net vehicle integration controlled demonstration	

USE OF FUNDS (₹5 CRORE)

#	Work package	₹ lakh	%
1	Large-area development	55	11%
2	Large-cell hardware	45	9%
3	10 kW stack	85	17%
4	BoP + controls	60	12%
5	NH ₃ storage + safety	40	8%
6	Vehicle integration + power electronics	35	7%
7	Durability testing	35	7%
8	External validation	25	5%
9	Technical team	70	14%
10	Regulatory engineering	20	4%
11	Contingency	30	6%
TOTAL		500	100%

PROPOSED MILESTONE-LINKED CAPITAL RELEASE (₹ LAKH)

PROPOSED MILESTONE-LINKED CAPITAL RELEASE (₹ LAKH)					PROPOSED GOVERNANCE STRUCTURE • NOT AN AGREED INVESTOR TRANCHE				
₹100 lakh		₹125 lakh		₹100 lakh		₹100 lakh		₹75 lakh	
M1 – M4		M4 – M10		M8 – M12		M15 – M19		M19 – M24	
25 cm ² BoP / air operation / durability		900 cm ² cell tooling and validation		Short stack development		Multi-kW stack + vehicle system (BoP, controls, thermal)		DAFC-10 demonstrator + validation	

GOVERNANCE AND REPORTING

 Monthly engineering report Progress, data and key risks	 Quarterly milestone review Technical, schedule and budget review	 Budget vs actual Transparent cost tracking	 Risk register Technical, safety and execution risks	 Experimental / simulated / target separation Clear labelling in all reports	 Failures reported openly Lessons learned and course corrections
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Disciplined capital deployment to de-risk technology, validate safety and deliver a 10 kW vehicle demonstrator in 24 months.

INVESTOR QUESTION:

WHO IS RESPONSIBLE FOR TAKING THE NEXT 24 MONTHS TO HARDWARE?

From measured cell to 10 kW vehicle evidence.

CORE TEAM



Sanjay Dakshinamoorthy
Founder & CEO

CAD/CAE, engineering integration, DAFC programme



Dr. Karthika A.
Co-Founder

Strategy, partnerships, fundraising



Pon Man Kishan
Business & Operations Head

Operations, programme coordination

TECHNICAL ADVISORS



Dr. Indrajit Shown
Fuel cells



Dr. Ganesan P.
Fuel cells



Dr. A. Krishna Kumari
Marine



Dr. M. Saravanan
Structures & materials



Dr. N. Rino Nelson
Product development

PROGRAMME ASSETS



25 cm² measured DAFC result

● EXPERIMENTAL



Patent filed
IN 202641059092



MATLAB/Simulink vehicle + system model

◆ SIMULATED



Incubated at MaDeIT • IIITDM Kancheepuram



VIT Chennai technical collaboration / NDA



₹10 lakh PoC grant Mar-a-thon 2025 / Cochin Port Authority

THE ASK

ROUND OBJECTIVE

₹5 CRORE

24 MONTHS

- **900 cm² CELL**
Large-area cell with 80 µm membrane
- **SHORT STACK**
10-cell short stack validation
- **10 kW DAFC-10**
Multi-kW stack, controls and thermal loop
- **SAFE VEHICLE INTEGRATION**
NH₃ containment, safety testing, power electronics
- **THREE-WHEELER DEMONSTRATOR**
10 kW net • Controlled demonstration



TARGET CONCEPT • H2ONE 3D ENGINEERING MODEL
Current packaging concept under engineering development and validation.
Not a tested vehicle result.



H2ONE
WEBSITE