

ULTRALIGHT MULTI-FUEL HTPEM FUEL CELL POWER SYSTEM



FOR ENERGY INTENSIVE APPLICATIONS

Breaking the **Weight Wall** and **Infrastructure Deadlock** to Decarbonize Hard-to-Abate Sectors

PROBLEM

Existing clean-energy solutions face fundamental limitations: batteries suffer from excessive **weight**, lengthy **downtime**, and **grid capacity** constraints, while conventional fuel cells (LTPEM) are paralyzed by a lack of a H2 **refueling network** and excessive system **bulk and complexity**

SOLUTION

Turbeon introduces an **ultralight, multi-fuel HTPEM fuel cell power system**. Proprietary architecture eliminates heavy liquid radiators and complex humidification systems, and allows the use of widely available liquid methanol today, while remaining 100% compatible with pure hydrogen tomorrow

MARKET

SAM for **Turbeon** energy systems is projected to reach **\$95.3B by 2035**, expanding at a 7.8% CAGR. Commercialization targets high-utilization sectors via a 10% market share licensing model, focusing on following key verticals: Aviation, Heavy Machinery, Maritime, and Ground Generation

TRACTION

- **1 binding MOA** executed with a commercial maritime partner, featuring fully funded R&D and a per-system royalty model
- **3 signed LOIs** secured from aviation and ground power generation industrial partners
- **7 patent applications** prepared for filing to secure the global core technology IP

TEAM

- **The original authors** and pioneers of turbo-air-cooled HTPEM fuel cell architectures
- **Serial entrepreneurs** delivering proven deep technical expertise and strong managerial discipline
- **\$100M exit** (HyPoint >> ZeroAvia) demonstrates successful commercial execution and industry validation

ASK

\$2.2M Pre-Seed funding round
to validate a 5kW H2/methanol HTPEM stack prototype (TRL-4), build an R&D laboratory, and secure the IP portfolio

Energy Transition is Inevitable

Community
Standards



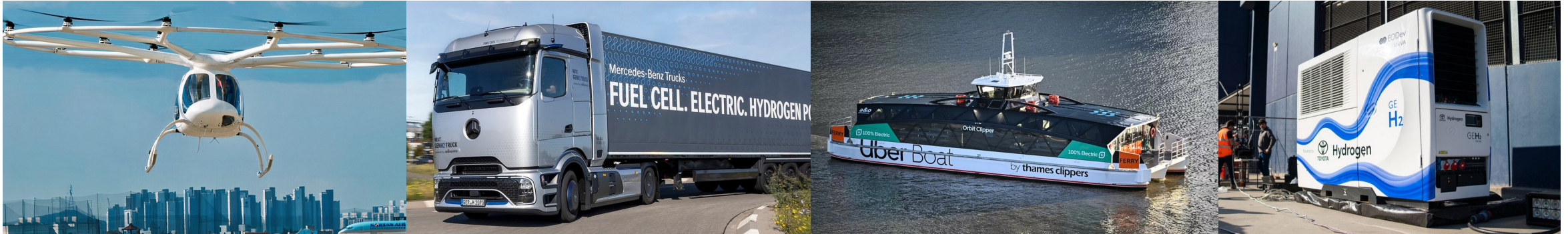
Economics
Efficiency



Strategic
Autonomy



Energy-intensive Applications Lack a Viable Clean-energy Solution



Li-Ion batteries

- ! Prohibitive weight
- ! Severe grid capacity constraints
- ! Lengthy charging downtime

Hydrogen fuel cells

- ! Excessive system bulk and weight
- ! Non-existent infrastructure
- ! High fuel costs

✗ Minimal progress

Turbeon Overcomes Industry Constraints

✓ LIGHTWEIGHT & COMPACT

50% lighter than closest competitors - no heavy and bulky radiators, no complex humidification systems

✓ MULTI-FUEL

Operates on both H₂ and liquid methanol - no infrastructure or charging time problem, low fuel cost

and Enables New Capabilities

✓ CLIMATE-AGNOSTIC

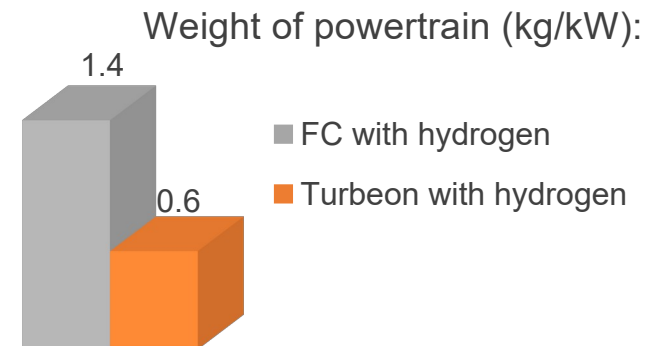
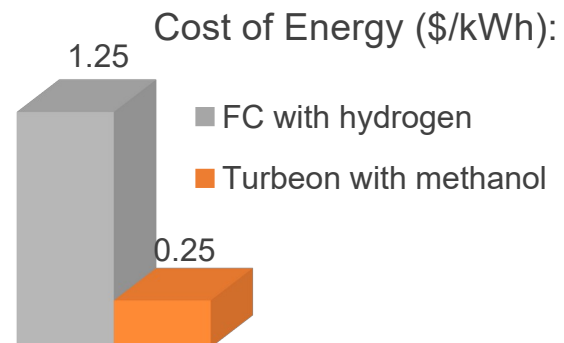
Reliable performance from extreme cold to blistering heat while remaining clean & quiet - no combustion, no vibration, no toxic emissions



How Turbeon wins over competitors

Turbeon is built on HT PEM fuel cells while competitors (Toyota, PowerCell, CellCentric) use traditional LT PEM technology. HT PEM operates at higher temperature ($130 \div 180\text{ }^{\circ}\text{C}$) than LT PEM ($60 \div 80\text{ }^{\circ}\text{C}$) and doesn't use water for membrane humidification. Turbeon innovations wouldn't be possible without HT PEM

Turbeon's advantages	How achieved	What competitors do
LIGHTWEIGHT & COMPACT	System has been simplified by implementing direct air-cooling for HT PEM fuel cell	Liquid-cooled LT PEM systems requiring radiators, coolants, pumps and humidifiers doubling system weight
MULTI-FUEL	Methanol reformer allows to work with hydrogen produced on-board from a liquid fuel	Operate with pure hydrogen, LT PEM can't work directly with synthesis gas produced in a reformer
CLIMATE-AGNOSTIC	High operating temperature and no water use	Low operating temperature and humidification with water limits ambient conditions to $-10...+35^{\circ}\text{C}$



Proprietary Innovations & Competitive Moat

Level	Innovation	Effect
System	1. Advanced Thermal Management & Pre-conditioning Architecture for HTPEM air-cooled FC System	40% System weight 20% volume reduction
	2. Multi-stack aerodynamic packaging	25% Reduction in power consumption for cooling
Stack	3. High-Performance Bipolar Plate Topology for Air-Cooled HTPEM fuel cells	3.5 kW/kg at the cell level 10% FC performance improvement
	4. BPP cooling channels design for air-cooled HT PEM FC	>5,000 Stack lifespan 25% pressure drop reduction
Reformer	5. High-Exergy Recuperation & Water-Closed Loop Architecture for Methanol-to-Power HTPEM fuel cell Systems	20% Methanol consumption reduction 50% water weight reduction
	6. Ultra-Compact High-Flux Methanol Reforming Reactor with Enhanced Thermal Control	5x Weight and volume reduction
MEA	7. Cost-effective and durable design of HT PEM MEA	3x MEA cost reduction >5,000 hours MEA lifespan at high currents

One Core Technology – Three Industry Solutions

Aviation



Ultra-light
Aerodynamically-shaped
power system

Heavy Machinery & Maritime



Highly-efficient
compact power plant with
built-in methanol reformer

Ground Generator



All-in-one
easy-to-handle all-weather
power module

Multi-Sector Market Potential

Serviceable Available Market	Segment	2030	2035	CAGR 2030-2035
Aviation Heavy Machinery & Maritime Ground Generation	Long-range eVTOL (>150 km), Heavy Cargo Drones (>25 kg payload)	\$2.4B	\$10.4B	34%
	Long-Haul/Heavy, Inland & Coastal Vessels, Port Logistics	\$53.6B	\$71.2B	5.8%
	Eco-friendly, low noise portable generators	\$9.5B	\$13.7B	7.6%
TOTAL	Turbeon Energy Systems	\$65.5B	\$95.3B	7.8%

Target: 10% Market share through licensing and key component sales

Go-to-Market Strategy



Year 1-2 Validation and IP Moat

Focus (TRL 4-5)

- ✓ Stack and System Prototypes
- ✓ Securing IP
- ✓ Equipped assembly and test laboratory

Revenue:

- ✓ JDA & NRE Fees

Funding:

- ✓ \$7M

Year 3 Market Entry

Focus (TRL 6-7)

- ✓ Commercial-Ready Power System
- ✓ Real-world tests and Brand recognition
- ✓ Hi-power System Test Rig

Revenue:

- ✓ JDA & NRE Fees
- ✓ Trial sales

Funding:

- ✓ \$7M

Year 4+ Global Scaling

Focus (TRL 7+)

- ✓ Modular Systems up to 350kW
- ✓ Licensing to Tier-1 OEMs to become the industry standard
- ✓ Equipped production line

Revenue:

- ✓ Key component sales
- ✓ Recurring Royalties
- ✓ JDA & NRE Fees

Funding:

- ✓ \$8M

Commercial Validation & Industry Engagement



PIASECKI AIRCRAFT CORPORATION (PiAC)

Major Aerospace & Defense Developer (US)

Signed LOI

Scope: Strategic collaboration to develop and integrate the Turbeon HTPEM Power Systems into PiAC current and future aircraft platforms and advanced aerospace products



RUKALA AERO

Advanced eVTOL & Zero-Emission Aircraft Developer (Australia)

Signed LOI

Scope: Integration & Flight validation of Turbeon HTPEM Power System for long-range eVTOL



SHANGHAI FUELTURE ENERGY

Leading Clean Energy Systems Integrator (China)

Signed LOI & MOA

Scope: Commercial marine & mobile power project; funded R&D with 3-7% gross sales royalty model



NEWCASTLE MARINE SERVICES

Premier Marine Engineering & Vessel Operator (UK)

UK Grant Consortium

Scope: Commercial marine validation with direct operational access to a fleet of offshore support vessels (CMD7, £966k)

Deep Tech Expertise. Successful Commercial Execution



Sergei Panov Product Development

- PhD, engineer and tech lead, 25+ years of industrial experience including 10+ years in FC
- Head of HTPEM Product Development at ZeroAvia, Co-founder and CTO at HyPoint, CEO and CTO at BMPower



Sergei Shubenkov Product Innovation

- Physicist (Ginzburg's theoretical group at MIPT), author of Turbo-Air-Cooled FC concept, 17+ years of experience in FC
- Head of innovation at ZeroAvia, Co-founder and R&D Director at HyPoint, Director of Technical Support at BMPower

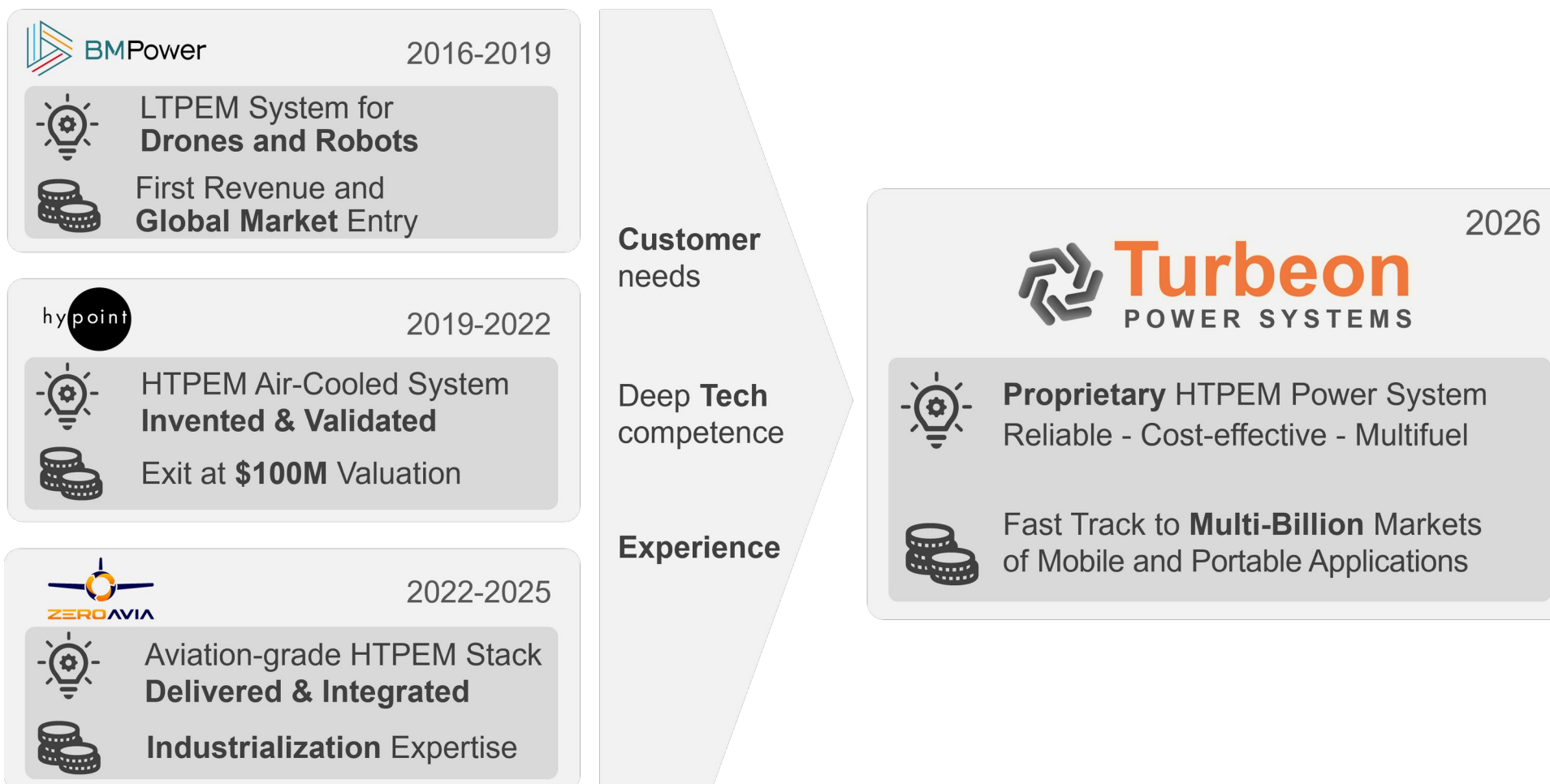
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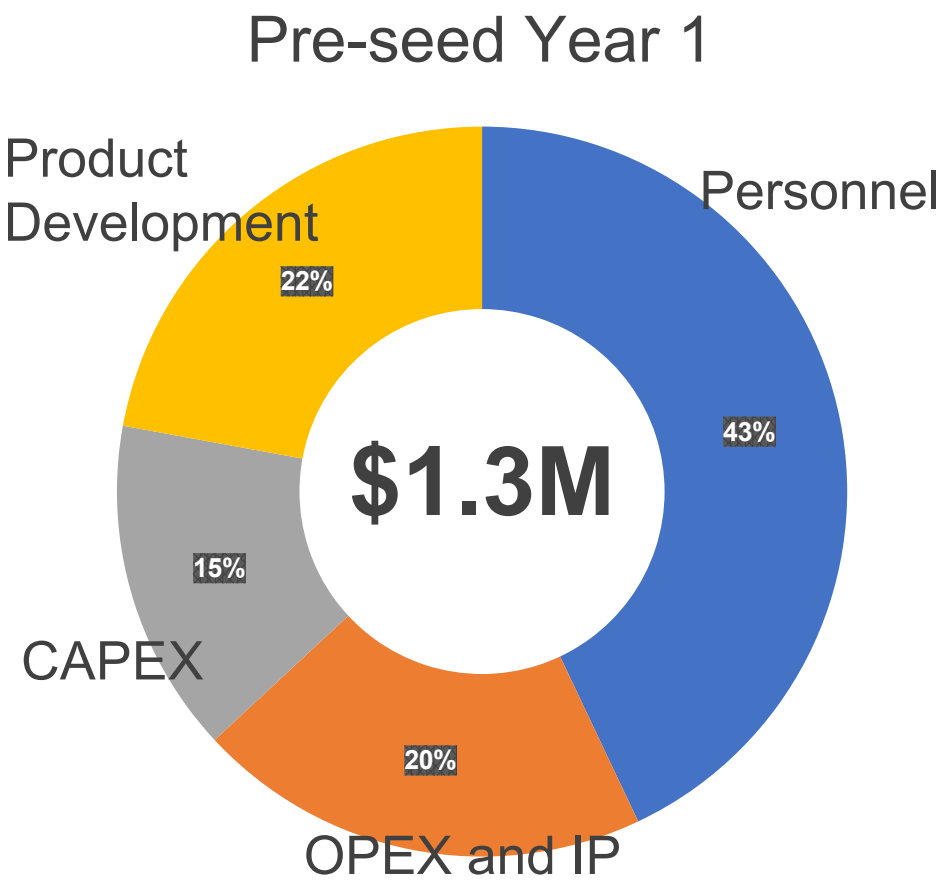
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Market-Driven Vision. Proven Product Delivery



Pre-Seed Funding & Growth Targets



Achievement	Impact
5 kW representative stack prototype build and tested	Technology validated
7 Patent applications submitted	IP Protected
Equipped Stack Assembly and Test Laboratory	Ready for Year 2 fast-track

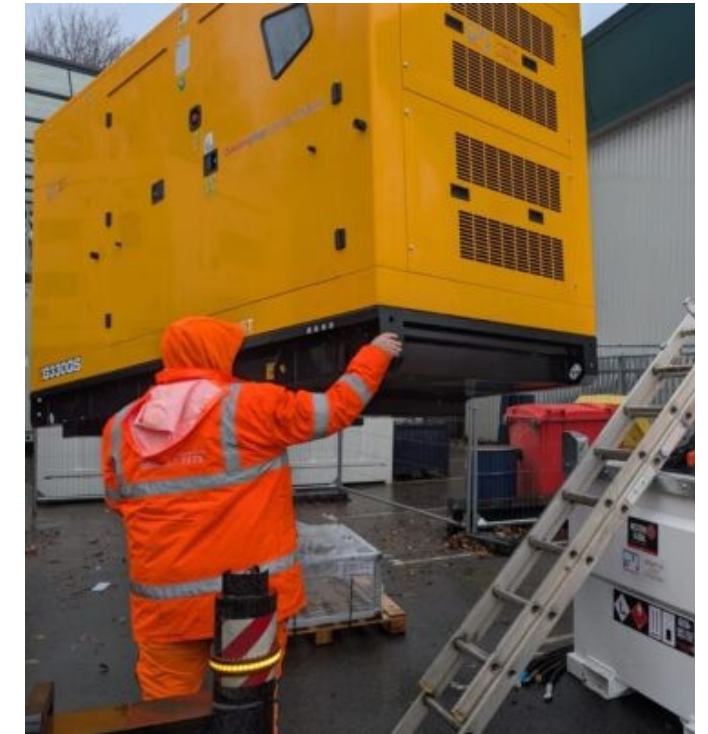


Looking forward to a strategic partnership

Sergei Panov | CEO | sp@turbeon.energy

Making standard gensets quiet and portable

Parameter	Diesel Generator (Silent execution)	Methanol-fuelled Turbeon
Nominal power capacity	60 kW	60 kW
Average power consumption	40 kW	40 kW
Average system efficiency	33%	42%
Fuel (65% methanol) tanks volume	120 l	270 l
Toxic emissions	Soot, NO _x	No
Electricity cost	0.6 \$/kW	0.4 \$/kW
Ambient temperature	-25°C ÷ +45°C	-40°C ÷ +55°C
Noise level@7 meters	62-67 dB	<57 dB
Dry system weight	1 370 kg	200 kg
Fuelled system weight	1 450 kg	410 kg
Total system volume	4.1 m ³	0.55 m ³



Turbeon can extend electric truck range by 5x

Truck powertrain characteristics	Volvo FH Electric	Hybrid with Turbeon
Max power output	540 kW	540 kW
Battery energy capacity	540 kWh	135 kWh
Turbeon power capacity (max continuous power)	n/a	160 kW
Fuel (methanol) tanks volume	n/a	1.5 m ³
Weight of the battery pack	~3600 kg	~900 kg
Weight of Turbeon incl. reformer and full tank	n/a	~1500 kg
Electricity/Fuel consumption per 100km	110 kWh	60 liters
Total powertrain weight with the full tank	~3.6 tons	~2.4 tons
Effective range on one tank	470 km	2500 km



Freeing critical weight and volume for payload

Heavy drone example:

- 150 kW peak power
- 90 kW avg. power
- 3 hours flight



Parameter	Li-ion	LT PEM + H ₂	Turbeon: H ₂	Turbeon: CH ₃ OH
Energy capacity of the system	300 kWh	20 kg of H ₂	20 kg of H ₂	CH ₃ OH (65%): 170 kg
Total volume of tanks (350 Bar for H ₂)	n/a	830 l	830 l	200 l
Time for refuelling/recharging	2 hours	15 minutes	15 minutes	5 minutes
Weight of the power generation system	n/a	215 kg	100 kg	230 kg
CAPEX	\$100,000	\$25,000	\$25,000	\$30,000
OPEX (EU average)	\$40/hour	\$160/hour	\$120/hour	\$45/hour
Ambient temperature	-10°C ÷ +40°C	-15°C ÷ +35°C	-40°C ÷ +55°C	-40°C ÷ +55°C
Total weight of the system	2 000 kg	440 kg	320 kg	400 kg
Total volume of the system	0.8 m³	1.1 m³	1.0 m³	0.65 m³