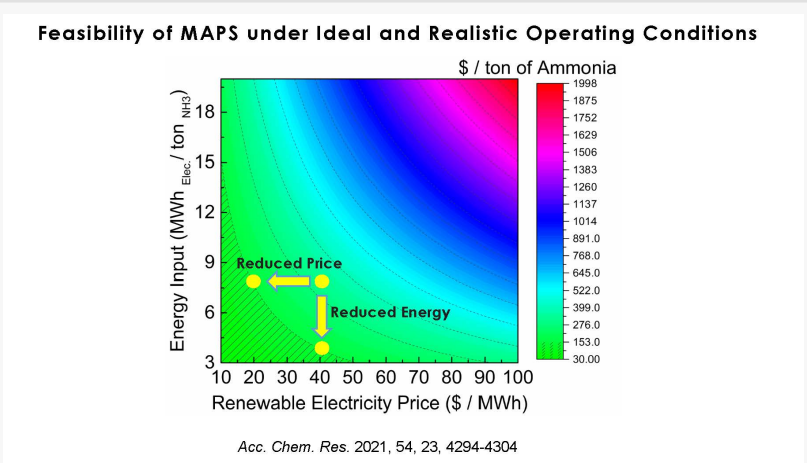
Green Ammonia and Hydrogen Now Cheaper than Fossil Fuels

Hydrofuel's licensing of Micro Ammonia Production System (MAPS) from Georgia Tech to combine with its Kontak Hydrogen from Ammonia Separation Modules



Source: Nazemi, M. and El-Sayed, M.A., 2021. Managing the Nitrogen Cycle via Plasmonic (Photo) Electrocatalysis: Toward Circular Economy. Accounts of chemical research, 54(23), pp.4294-4304.

MISSISSAUGA, ONTARIO, CANADA, April 26, 2022 /EINPresswire.com/ -- Hydrofuel Canada Inc. ("Hydrofuel"), a company engaged in delivering Green Ammonia and Hydrogen along the last mile to its customers, has completed an exclusive licence agreement with Georgia Institute of Technology ("Georgia Tech") for their patent pending MAPS system which enables high-yield, sustainable ammonia synthesis from air and water with unprecedented efficiency using a gas-phase electrochemical process.

> Our mission to provide Green Hydrogen from ammonia to end users with lower costs and life cycle pollution than any other fuel is now within our reach"
>
> *Greg Vezina, Hydrofuel Canada Chairman and CEO*

Utilizing MAPS technology with renewable energy to produce cost effective green ammonia is a major development. Using that ammonia with Kontak's technology, which Hydrofuel has previously acquired, is a game changer.

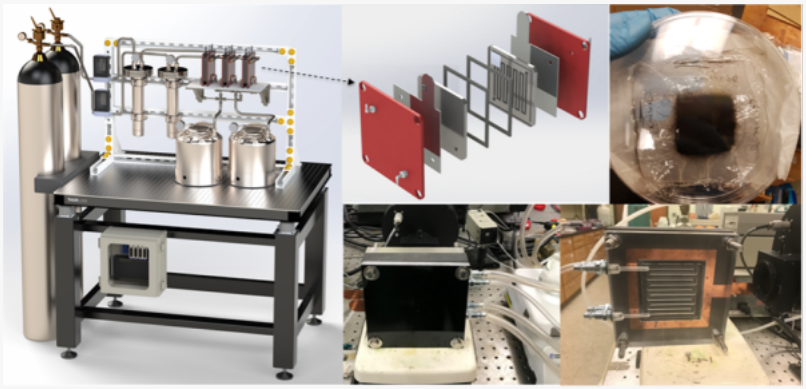
Combined, these technologies allow Hydrofuel to produce Green NH3 using $.02/kWh electricity for as low as $220 a tonne, whereas fossil-fuel derived NH3 is currently selling at $1,500 to $2,000 a tonne.

Green Hydrogen can be separated out from this ammonia to sell at about $1.50 a kg, compared to traditional green H2 which sells for up to $15 a kg. Even at $.08/kWh the production of green Ammonia and releasing Hydrogen from it will be lower cost than any hydrocarbon fuel.

The MAPS ammonia production technology uses hollow hybrid plasmonic nanocages to create a highly effective electrocatalyst for ammonia synthesis from nitrogen (N2) and electrolyzed water (H2O) under ambient temperatures and pressure in the gas- and liquid-phase system.

Ammonia is a significant energy carrier and is an essential ingredient in fertilizer production, globally. Georgia Tech researchers have developed a sustainable and environmentally friendly production method that enables a high ammonia yield rate with unprecedented energy efficiency.

Ammonia (NH3) molecules contain one part nitrogen, and three parts hydrogen. NH3 is a promising and environmentally friendly fuel source because it is carbon free, it contains 1.5 times more hydrogen than liquid hydrogen (H2), and it can reduce global GHG emissions substantially by displacing fossil fuels.



Figures Schematic of the gas-phase (photo) electrochemical cell for nitrogen fixation using hybrid plasmonic nanocages. (center top) In this setup, the catalyst materials are painted on both sides of the membrane surface, as shown in the top right image.

Hydrogen and Ammonia Energy Input

CHARACTERISTICS	UNITS	2011 STATUS	2015 TARGET	2020 TARGET
Hydrogen levelized cost [d] (production only)	$/kg	4.20 [d]	3.90 [d]	2.30 [d]
Electrolyzer system capital cost	$/kg	0.70	0.50	0.50
	$/kW	430 [e,f]	300 [f]	300 [f]
System energy efficiency [g]	% (LHV)	67	72	75
	kwh/kg	50	46	44
Stack energy efficiency [h]	% (LHV)	74	76	77
	kwh/kg	45	44	43
Electricity price	$/kWh	From AEO 2009 [i]	From AEO 2009 [i]	0.037 [j]

177 kg of hydrogen is needed to make a ton of ammonia

44 MWh per ton of hydrogen × 0.177 ton of hydrogen / per ton of ammonia = 7.7 MWh

The above value represents the amount of electricity per ton of ammonia that is needed to make the required hydrogen from water electrolysis!!

Cost of Producing Ammonia & Hydrogen - MAPS & KONTAK

Electricity Price ($/kWh)	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
NH3 ($/ton)	129	220	284	360	438	515	591	668	745	822
NH3 ($/GGE)	0.84	1.43	1.85	2.34	2.85	3.35	3.85	4.35	4.85	5.35
NH3 ($/DGE)	0.95	1.62	2.09	2.65	3.22	3.78	4.34	4.91	5.48	6.04
H2 ($/kg)	1.15	1.32	1.50	1.68	1.86	2.04	2.21	2.39	2.57	2.75
H2 ($/GGE)	1.14	1.32	1.50	1.68	1.85	2.03	2.21	2.38	2.56	2.74
H2 ($/DGE)	1.30	1.50	1.70	1.90	2.11	2.31	2.51	2.71	2.91	3.11

Hydrogen and Ammonia made from Electricity at $.02 to $.10 kWh, with Gasoline & Diesel Equivalent Costs.

Storing hydrogen energy in ammonia is more efficient than pure hydrogen as it doesn't leak through the walls of containers and pipelines. The atomic weight of the fuel makes it a perfect carrier of hydrogen for commuter, eVTOL, drone, and regular aircraft travel, as well as for marine, transport truck, agricultural and industrial and power generation uses.

The MAPS technology can decentralize the production of ammonia and hydrogen while it consumes significantly less energy than current methods, permitting local or on-site production with renewable electricity sources and long-term energy storage.

Hydrofuel and MAPs co-inventor Reza Nazemi are negotiating an agreement with Colorado State University to complete a commercial application and demonstration of the MAPS technology, commencing in July of 2022.

Benefits/Advantages of MAPs Technology

- Simplified process: Enables production of ammonia via gas-phase system with few or no additional steps for separation and purification
- Reduced carbon footprint: Enables decentralized production so that farmers can make their own fertilizer on site, eliminating the need to transport it
- Long-term energy storage: Stored renewable energy in the form of liquid ammonia containing hydrogen that can easily be transported and delivered to end-users for various applications in the energy and transportation industries (e.g., power, combined heating

Kontak's technology can efficiently release hydrogen from a dozen potential carrier molecules identified so far. Of the carriers, the highest storage capacity is anhydrous ammonia, with (17.3% hydrogen by weight) stored in liquid form like propane.

Kontak's patented reactor is the most effective method to date for releasing hydrogen. The hydrogen is filtered and sent directly to a fuel cell or internal combustion engine. The technology was developed under a National Science Foundation Grant. The Hydrogen Release Module is USPTO #10,207,241B2 with patents pending in multiple countries.

Kontak also has patents pending on a modular low-cost combined hydrogen, ammonia, and battery energy station technology that can store as much as three times the energy of conventional systems.

Hydrofuel's Ammonia Solutions© aftermarket multi-fuels engine retrofit systems will be used for a low emission combination of diesel and ammonia fuel, and zero emission hydrogen oxygen assisted NH3 fuel.

Toronto, Ontario-based TFX International SPECIALIZED VEHICLE TRANSPORT will provide two diesel fuelled generators and transport trucks to be converted to use Hydrofuel® ammonia/hydrogen fuel over three years, beginning in 2023.

About Hydrofuel Canada Inc.:

Located in Mississauga, Ontario, Hydrofuel Canada Inc. is focused on providing low cost, last – mile Green Ammonia and Hydrogen solutions to its customers. Hydrofuel's proprietary technologies include modular re-fueling stations for Hydrogen and EV charging, MAPS technology for low-volume, low cost production of Green Ammonia and Hydrogen separation Module for highly efficient separation of Hydrogen from Ammonia. Hydrofuel has over 40 years of experience in Ammonia energy and fuel systems technologies. Hydrofuel®™ and Ammonia Solutions© are registered Trademarks and Copyrighted. https://nh3fuel.com

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