

# Novel Gas

**~90% Efficient Electrolyzer and ~44% Efficient  
Solar Technology Achieves ~\$1/kg of H<sub>2</sub>**

**Best-in-Class H<sub>2</sub> System will be a Technological  
Breakthrough and Underpin the Hydrogen Economy!**



The hydrogen future is here now.



**"Discoveries are often made by not following instructions, by going off the main road, by trying the untried." - Frank Tyger.**

- **NovelH<sub>2</sub>Gas** patent pending turnkey scalable 5 MW modular system includes a ~90% energy efficient electrolyzer, ~44% energy efficient novel solar photovoltaic (PV) technology, and proprietary **HWC** machine creates an additional ~42% of free electricity provides low-cost hydrogen that costs ~\$1/kg of H<sub>2</sub>.
- **NovelH<sub>2</sub>Gas** proprietary's **HWC** machine generates an additional ~42% of free electricity that will operate the electrolyzer for an additional ~6 to 8 nighttime hours increasing the daily kg/H<sub>2</sub>.
- **NovelSolarPV** transformative solar PV technology provides low-cost electricity for electrolyzers.
- Lower CapEx and OpEx compared to conventional solar photovoltaic (PV) panels.
- 2x more renewable energy than conventional solar PV, and 2x more profitable.
- Generates the most solar energy per m<sup>2</sup>.
- Achieves over two times more energy than conventional solar PV.
- Solar PV is more than double the efficiency of conventional PV.
- Provides more energy output and long-term savings.
- Low-cost kWh saves hydrogen producers a significant amount of money operating their electrolyzers.
- Solar PV technology combined with proprietary **HWC** machine maximizes electricity production.
- Hydrogen plant is scalable in 5 MW modules.
- **NovelH<sub>2</sub>Gas** hydrogen equipment system and solar PV are proven equipment.

# INTRODUCTION – NovelSolarPV achieves ~\$1/kg of H<sub>2</sub>

A rise in environmental and anthropogenically induced greenhouse gas emissions has resulted in a top priority to address the climate crisis with clean energy to overcome these challenging concerns and achieve the Paris Climate Accord Agreement's priorities to achieve net-zero by 2050. Hydrogen gas is expected to be a fundamental fuel in future energy carrier materials and manufacturing processes.

One of the Department of Energy's Hydrogen Shot Initiative's goal is affordable clean hydrogen cost is ~\$1/kg within the decade. Therefore, green hydrogen requires a new novel approach.

First-of-its-kind, transformative patent pending turnkey scalable 5 MW modular system includes a ~90% efficient electrolyzer, and ~44% efficient solar technology in achieving ~\$1/kg of H<sub>2</sub>.

HWC proprietary machine generates an additional ~42% of free electricity enabling the electrolyzer to operate for an additional ~6 to 8 nighttime hours increasing the daily kg/H<sub>2</sub> gross revenues.

Disruptive ~90% efficient electrolyzer and ~44% solar technology are a much lower CapEx and OpEx compared to conventional electrolyzers and solar technologies.



NovelH<sub>2</sub>Gas patent pending turnkey scalable 5 MW modular system includes a novel ~90% efficient electrolyzer, ~44% efficient solar technology, and proprietary HWC machine generates an additional ~42% of free electricity that will operate the electrolyzer for an additional ~6 to 8 nighttime hours.

NovelH<sub>2</sub>Gas system has the potential to be a transformative and emerging green hydrogen technology compared to the two expensive state-of-the-art hydrogen technologies which are steam methane reforming and PEM electrolyzers.

NovelH<sub>2</sub>Gas system economically achieves green hydrogen gas with its novel ~90% electrolyzer compared to expensive ~70% PEM electrolyzers and novel ~44% efficient solar technology that saves substantial CapEx and OPEX.

NovelH<sub>2</sub>Gas mission is to license a transformative ~90% efficient electrolyzer and ~44% efficient solar technology that is cost competitive with fossil fuels.

NovelH<sub>2</sub>Gas supports the Paris Climate Accords' goals to shift to greener fuels to achieve net zero emissions by 2050.

Hydrogen is the Fuel of the Future.

# PROBLEMS WITH PEM ELECTROLYZERS

**Electrolysis** is the process of using electricity to split water into **hydrogen** and oxygen. The reaction takes place in a unit called an electrolyzer.

**Key challenge** is the efficient production of **hydrogen** to meet the commercial-scale demand of **hydrogen**. Water splitting electrolysis is a promising pathway to achieve efficient **hydrogen** production.

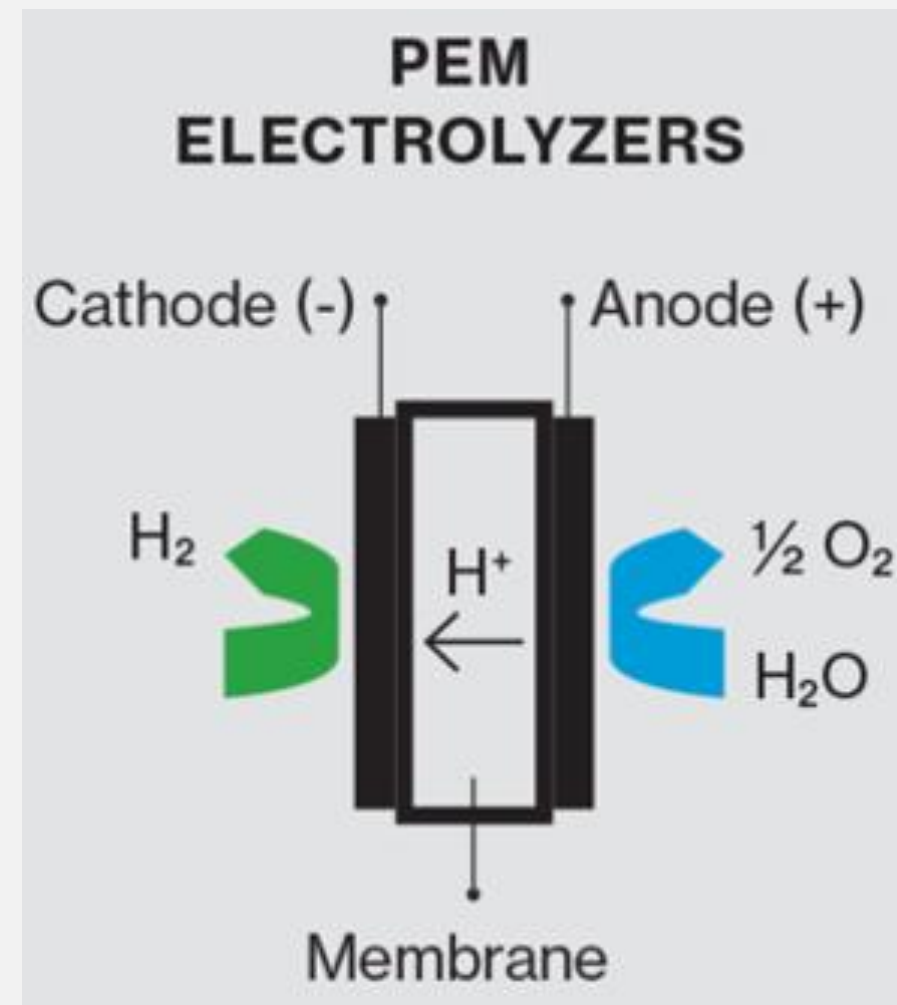
**Electrolysis currently presents two major challenges: cost and efficiency.** Research efforts worldwide are attempting to overcome these challenges and improve electrolysis viability.

**Environmental impacts of electrolysis** depend on the fuels and technologies used to generate the electricity used in the process. Use of conventional grid power would generate more global warming pollution than steam methane reforming with natural gas.

**Disadvantages of electrolysis of water** is that it takes a lot of energy to separate the water into **hydrogen** and oxygen. If you burn fossil fuels to create the energy for electrolysis process it produces lots of CO<sub>2</sub> emissions. Thus, high-cost renewable solar energy is the preferred energy source to convert to electricity.

## HIGH EQUIPMENT AND OPERATING COSTS

Membranes significantly increase the complexity of PEM electrolyzers leading to high manufacturing costs. PEM electrolyzers require precious metals further increasing cost. External compressors required due to low **hydrogen** pressure and cooling required due to heat generated by the inefficient process add to the equipment cost.



# SOLUTION COMPARED TO PEM ELECTROLYZERS

**NovelH<sub>2</sub>Gas** system is a disruptive ~90% efficient electrolyzer with a ~44% efficient solar technology.

- HWC proprietary machine generates an additional ~42% of free electricity enabling the ~90% efficient electrolyzer to operate for an additional ~6 to 8 nighttime hours increasing the daily kg/H<sub>2</sub> and electricity's gross revenues increasing the daily kg/H<sub>2</sub> gross revenues.
- PEM electrolyzers are inefficient and requires large capital investments making it non-competitive with fossil fuel extraction methods.
- Significantly reduced CapEx and OpEx.
- ~90% efficient electrolyzer at average cell voltages of 1.44–1.60 V with nominal current densities of 10–200 mA cm<sup>-2</sup>.
- ~90% efficient electrolyzer facilitates hydrogen at high-pressure and requires less maintenance.
- The novel hydrogen system makes the ~90% efficient electrolyzer more compatible with renewable power sources.
- Disruptive ~90% efficient electrolyzer is about ~48% lower CapEx and a lower OpEx compared to ~70% efficient PEM electrolyzers.
- ~90% efficient electrolyzer enables green hydrogen production at high pressure and high energy efficiency that is >20% more efficient than PEM electrolyzers.



**Green hydrogen is emerging as a promising fuel of the future.**

## PROBLEMS WITH CONVENTIONAL PV

- ✘ **Biggest problem conventional solar PV poses is it generates energy while the sun is shining. That means nighttime and overcast days can interrupt the operation and supply.**
- ✘ **A conventional photovoltaic panel converts 20% of incoming solar light into electricity and the rest of the energy (80%) is lost as heat.**
- ✘ **Only 15-22% efficiency with PV panels alone where the balance of solar radiant heat is lost.**



- ✔ **NovelSolarPVT solution obtains over two time more energy than conventional PV.**

## SOLUTION - NovelSolarPV achieves ~\$1/kg of H<sub>2</sub>

- ✓ Novel solar technology efficiency is ~44%.
- ✓ 2x more renewable energy than conventional PV.
- ✓ 2x more profitable than conventional PV.
- ✓ Proprietary HWC machine generates an additional ~42% of free electricity enabling the electrolyzer to operate for an additional ~6 to 8 nighttime hours increasing the daily kg/H<sub>2</sub> and electricity's gross revenues.
- ✓ Solar technology provides unparalleled energy efficiency providing more energy output and long-term savings than PEM electrolyzers.
- ✓ Low-cost per-kilowatt energy provides long-term cost savings.
- ✓ Solar technology generates the most energy per m<sup>2</sup>.
- ✓ Solar technology minimizes the thermal losses of the collector and maximizes electricity production.
- ✓ Solar collector obtains two times more energy than conventional photovoltaics (PV).
- ✓ Proprietary HWC machine significantly increases the solar technology's electrical output.



# VALUE PROPOSITION

## NovelH<sub>2</sub>Gas Green Hydrogen Achieves ~\$1/kg of H<sub>2</sub>

- ✓ **NovelH<sub>2</sub>Gas** HWC proprietary machine enables the electrolyzer to operate for an additional ~6 to 8 nighttime hours increasing daily kg/H<sub>2</sub> gross revenues.
- ✓ **NovelH<sub>2</sub>Gas** ~90% efficient electrolyzer cost \$590,000 per MW.
- ✓ Novel solar technology is cost-effective with a ~44% efficiency that achieves 2x more energy per m<sup>2</sup> than conventional solar technology.
- ✓ Tax credits available through 2032:
  - 1) Investment tax credit (ITC) reduces the federal income tax liability for 30% of the cost a solar system;
  - 2) The production tax credit (PTC) is a per kilowatt-hour (kWh) tax credit for electricity generated by solar = \$2.75 kWh.
  - 3) Inflation Reduction Act's hydrogen tax credit of \$3/kg H<sub>2</sub> and 2.6 cents per kWh.
- ✓ **NovelH<sub>2</sub>Gas** green hydrogen is significantly lower capital and production cost than PEM electrolyzers and steam methane reforming used for industry feedstock.
- ✓ There is no other green hydrogen electrolyzer technology achieving ~90% efficiency and ~44% efficient solar technology.
- ✓ **NovelH<sub>2</sub>Gas** equipment is proven and achieved successful proof of concepts.

## Lower Costs = Higher Profit Margins

- ✓ **NovelH<sub>2</sub>Gas** system is committed to delivering best-in-class, green hydrogen for a significantly lower cost than PEM electrolyzers for ~\$1/kg of H<sub>2</sub>.
- ✓ **NovelH<sub>2</sub>Gas** system is a much lower cost compared to PEM electrolyzers of about ~\$7.20 kWh per kg of hydrogen.
- ✓ **Mission Statement:** License **NovelH<sub>2</sub>Gas** system for hydrogen producers to efficiently produce green hydrogen for ~\$1/kg of H<sub>2</sub>.
- ✓ **Company's Motto:** **NovelH<sub>2</sub>Gas** aims to achieve the lowest green hydrogen production cost in the industry.
- ✓ **Long-Term Vision** is to help the hydrogen industry accelerate a decarbonized economy with low-cost green hydrogen gas.
- ✓ **NovelH<sub>2</sub>Gas** system is solely based on how we differ from the competition by focusing on our unique hydrogen technology's value proposition and providing exceptional value to customers.

Hydrogen is the Fuel of the Future.





# NovelH<sub>2</sub>Gas BENEFITS of Green Hydrogen Production

## Economical ~90% Efficient Electrolyzer and ~44% Efficient Solar Technology Compared to Conventional Hydrogen Systems

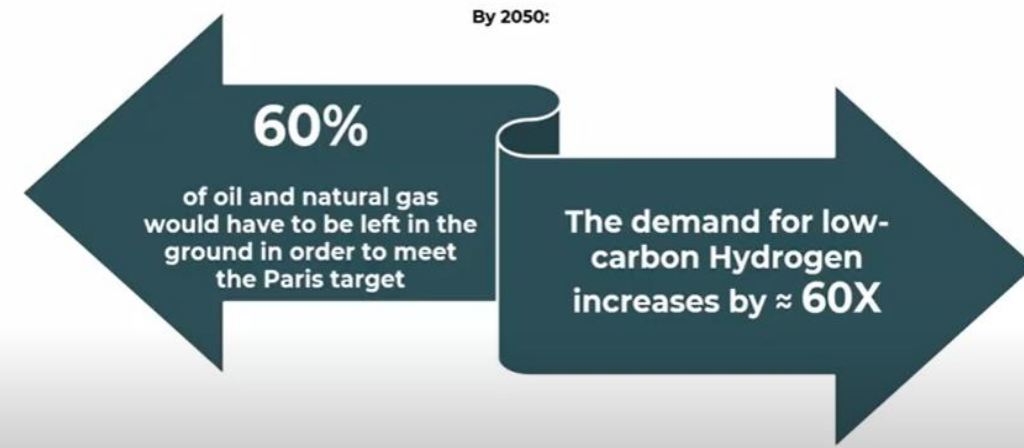
- ~90% efficient advanced electrolyzer
- ~20% more efficient than PEM electrolyzer
- Green hydrogen costs ~\$1/kg
- ~44% efficient advanced solar technology
- 2x more profitable than conventional PV
- Achieves low-cost kWh energy to operate electrolyzers
- Generates more energy per m<sup>2</sup>
- 2x more energy than conventional PV
- Produces ~120% MORE energy than conventional PV
- Proprietary HWC system generates an additional ~42% of free electricity
- System operates electrolyzer for an additional ~6 to 8 nighttime hours
- Scalable in 5 MW modules
- 30% solar tax credit
- IRA tax credit of \$3/kg
- Patent pending system



NovelH<sub>2</sub>Gas system is a novel and transformative ~90% efficient electrolyzer with a ~44% efficient solar technology for low-cost hydrogen.

## NovelH<sub>2</sub>Gas Best-in-Class System is a Transformative Green Hydrogen Technology for ~\$1/kg of H<sub>2</sub>

What to do with the unextractable fossil fuels in a 1.5°C world



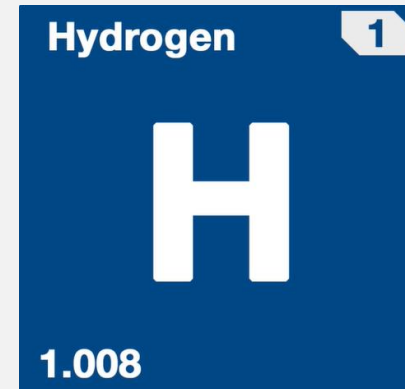
The hydrogen future is here now.

# TECHNOLOGY METRICS & CO2 COMPARISON

Hydrogen Production Technologies Summary of Features	NovelH2Gas	Competitor #1 Electrolysis with Renewable Solar Energy	Competitor #2 Electrolysis with kWh From the Grid	Competitor #3 Steam Methane Reforming
<b>Hydrogen cost/kg</b>	~\$1.00/kg	~\$16.80/kg	~\$7.20/kg	~\$1.80/kg
<b>CapEx and OpEx</b>	Low	Extremely High	Extremely High	Extremely High
<b>Energy Efficiency</b> HHV- Higher Heating Value System Efficiency	~98.7% ~95%	~75% ~70%	~75% ~70%	~78.7% ~74.6%
<b>Fuel Source</b>	Solar Energy – 42 kWh to make 1 kg of H <sub>2</sub>	Solar Energy – 52.5 kWh to make 1 kg of H <sub>2</sub>	Electricity – 52.5 kWh to make 1 kg of H <sub>2</sub>	Natural Gas and Electricity

Hydrogen is the Fuel of the Future.

CO2 Comparison for Hydrogen Gas Production Technologies				
CO2 Comparison	NovelH2Gas	Electrolysis using Solar Energy	Electrolysis using Grid Electricity	Steam Methane Reforming
<b>Energy Used</b>	0	0	49 kwh	MMBtu
<b>Factor</b>	N/A	N/A	0.533606 lb/kWh	53.02 kg CO2/MMBtu
<b>CO2 Emissions (mt)</b>	0	0	0.0576	0.0090
				*WECC and EGRID 2021
<b>lb</b>	26.146694			4.5 cubic meter gas to produce 1 kg Hydrogen Gas
<b>kg</b>	57.64300159			1 MMBtu=26.8 cubic meters
<b>mt</b>	0.057643002			0.17 MMBtu/kg Hydrogen Gas
				9.0134 kg CO2
				0.0090134 CO2 mt



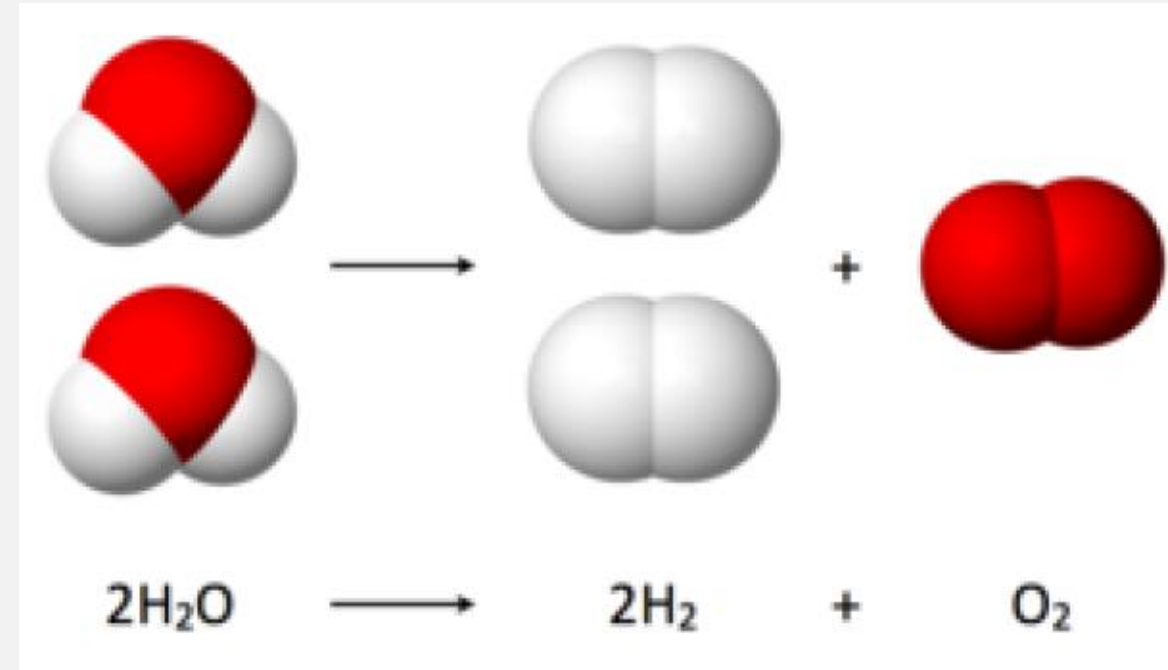
# PROCESS OVERVIEW BENEFITS

- ✓ **NovelH<sub>2</sub>Gas** best-in-class system is an end-to-end system with a ~90% efficient electrolyzer and ~44% efficient solar technology achieving low-cost hydrogen for ~\$1/kg of H<sub>2</sub>
- ✓ **NovelH<sub>2</sub>Gas** system enables the electrolyzer to operate for an additional ~6 to 8 nighttime hours increasing the daily kg/H<sub>2</sub> and electricity's gross revenues.

## NovelH<sub>2</sub>Gas technology

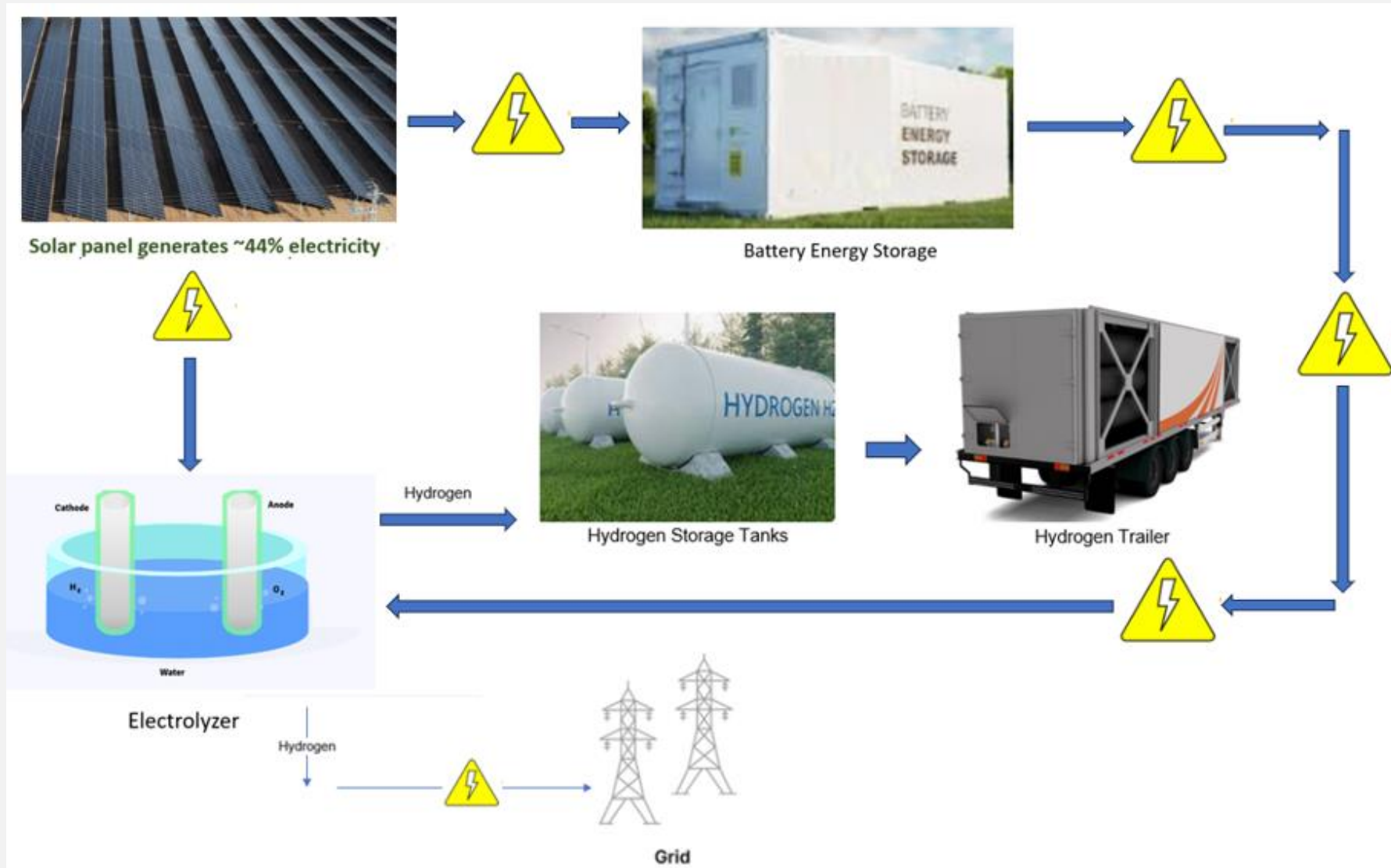
- ~90% efficient electrolyzer separates hydrogen and oxygen molecules;
- Reactor is suitable for high-pressure hydrogen production that avoids exorbitant capital equipment cost compared to PEM electrolyzers;
- Novel electrolyzer enables low-cost green hydrogen to achieve ~90% system efficiency for a much lower CapEx and OpEx compared to ~70% system efficient PEM electrolyzers;
- ~44% efficient solar technology provides a low-cost method utilizing its HWC proprietary machine to generate an additional ~42% of free electricity increasing the daily kg/H<sub>2</sub>.

**NovelH<sub>2</sub>Gas system is a transformational ~90% efficient electrolyzer and ~44% efficient solar technology that is in a "class by itself" and therefore "unique and innovative"**



# PROCESS FLOW DIAGRAM

90% Efficient Electrolyzer and 44% Efficient Solar Panels



## ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION # <b>63/578,374</b>	RECEIPT DATE / TIME <b>08/24/2023 08:52:34 AM ET</b>	ATTORNEY DOCKET # <b>LIPKENT001</b>
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### Title of Invention

**SYSTEMS AND METHODS FOR DELIVERY OF THERMAL ENERGY FOR H<sub>2</sub> AND ELECTRICITY PRODUCTION**

### Application Information

APPLICATION TYPE	Utility - Provisional Application under 35 USC 111(b)	PATENT #	-
CONFIRMATION #	7758	FILED BY	yogesh bhardwaj
PATENT CENTER #	62689449	FILING DATE	-
CUSTOMER #	49332	FIRST NAMED INVENTOR	Kent B. Hytken
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Willie Jacques

### Documents

**TOTAL DOCUMENTS: 5**

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
ADS_ThermalEnergy.pdf	8	Application Data Sheet	1226 KB
Oath_Thermal Energy.pdf	2	Oath or Declaration filed	100 KB
POA_Thermal Energy.pdf	4	Power of Attorney	1295 KB
Coversheet_ThermalEnergy.pdf	3	Provisional Cover Sheet (SB16)	1492 KB
Specification_Thermal Energy-APP.TEXT.docx	20	Application body structured text document	1243 KB



## NovelH<sub>2</sub>Gas best-in-class system achieves low-cost green hydrogen for ~\$1/kg of H<sub>2</sub>

There are four main sources for the commercial production of hydrogen: natural gas, oil, coal, and electrolysis; which account for 48%, 30%, 18% and 4% of the world's hydrogen, respectively. Fossil fuels are the dominant source of industrial hydrogen.

Public pressure is rising to limit global warming to 1.5 degrees Celsius, and global leaders are grappling with how to best take on this unprecedented challenge. Full decarbonization requires a multidimensional strategy, which has spurred renewed interest in hydrogen.

NovelH<sub>2</sub>Gas system achieves low-cost green hydrogen for ~\$1/kg of H<sub>2</sub> with its ~90% electrolyzer that costs \$590,000 per megawatt, ~44% efficient solar technology, and HWC proprietary machine generates an additional ~42% of free electricity increasing the daily kg/H<sub>2</sub> gross revenues.

NovelH<sub>2</sub>Gas system is a disruptive ~90% efficient electrolyzer for a lower CapEx and OpEx compared to ~70% energy efficiency PEM electrolyzers.

NovelH<sub>2</sub>Gas system is a disruptive ~90% efficient electrolyzer, ~44% efficient solar technology, and HWC proprietary machine generates an additional ~42% of free electricity for nighttime operations.



# ENVIRONMENTAL, SOCIAL AND GOVERNANCE (ESG)

## The global race for clean hydrogen means new geopolitical realities.

The global race for clean hydrogen means new geopolitical realities. If the 1990s were the decade of wind, the 2000s is the decade of solar energy, the 2010s is the decade of batteries, and the 2020s could launch us toward a next frontier of the energy transition: green hydrogen. Hardly a week goes by without a major new hydrogen breakthrough. In just the past five years, more than 30 countries have developed or started to prepare national hydrogen strategies (IEA 2022). The Paris Climate Accords' goal is to shift to greener fuels to achieve net zero emissions by 2050.

## Hydrogen battles

The pathway for clean hydrogen growth remains contentious, however. Two primary fault lines have emerged: how to produce it and in which sectors to deploy it.

**Future Energy LLC** is bringing a patent pending turnkey scalable 5 MW modular system, best-in-class, and first-of-its-kind hydrogen system with a ~90% efficient electrolyzer, ~44% efficient solar technology and **HWC** machine for a low-cost of ~\$1/kg of H<sub>2</sub>.

What sets **Future Energy** apart is our patent pending turnkey system's green hydrogen technology that will help navigate the emission reduction mandate to achieve reduced emissions producing green hydrogen for a low cost ~\$1/kg and enables the electrolyzer to operate for an additional ~6 to 8 nighttime hours increasing the daily kg/H<sub>2</sub> and electricity's gross revenues.

**Future Energy's NovelH<sub>2</sub>Gas** system is positioned to help produce clean green hydrogen gas efficiently and economically to achieve decarbonization and net-zero emissions by 2050.

**Future Energy LLC** is pleased to support Social Contract values and is building a purpose driven clean energy technology business to successfully implement the green hydrogen gas technology to enhance their objectives to achieve Environmental, Social and Governance (ESG) standards that safeguard the environment. We desire to help the community's citizens health and well-being to provide the societal benefits to the environment by improving air quality and maintaining high paying jobs improving the local economy.



**NovelH<sub>2</sub>Gas** system has a ~90% efficient electrolyzer, ~44% efficient solar technology, and proprietary **HWC** machine generates an additional ~42% of free electricity produces **green hydrogen** for ~\$1/kg of H<sub>2</sub>

## CONTACT INFORMATION

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Getting to  
**NET-ZERO  
EMISSIONS** by 2050

