# Accelerating the Energy Transition with Geologic Hydrogen & Complementary Technologies:

## Leveraging AI, Drilling Technologies, Extraction, Renewable Energy, Energy Storage to Produce Reliable Electricity and Renewable Fuels

**January 29, 2025**

By Paul Stevers
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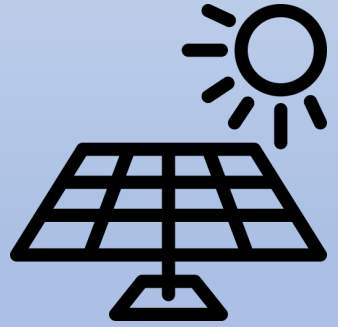
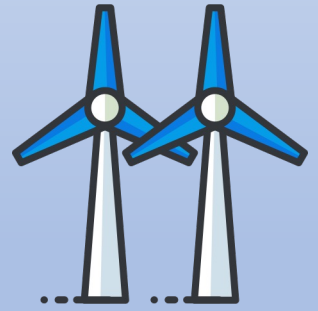

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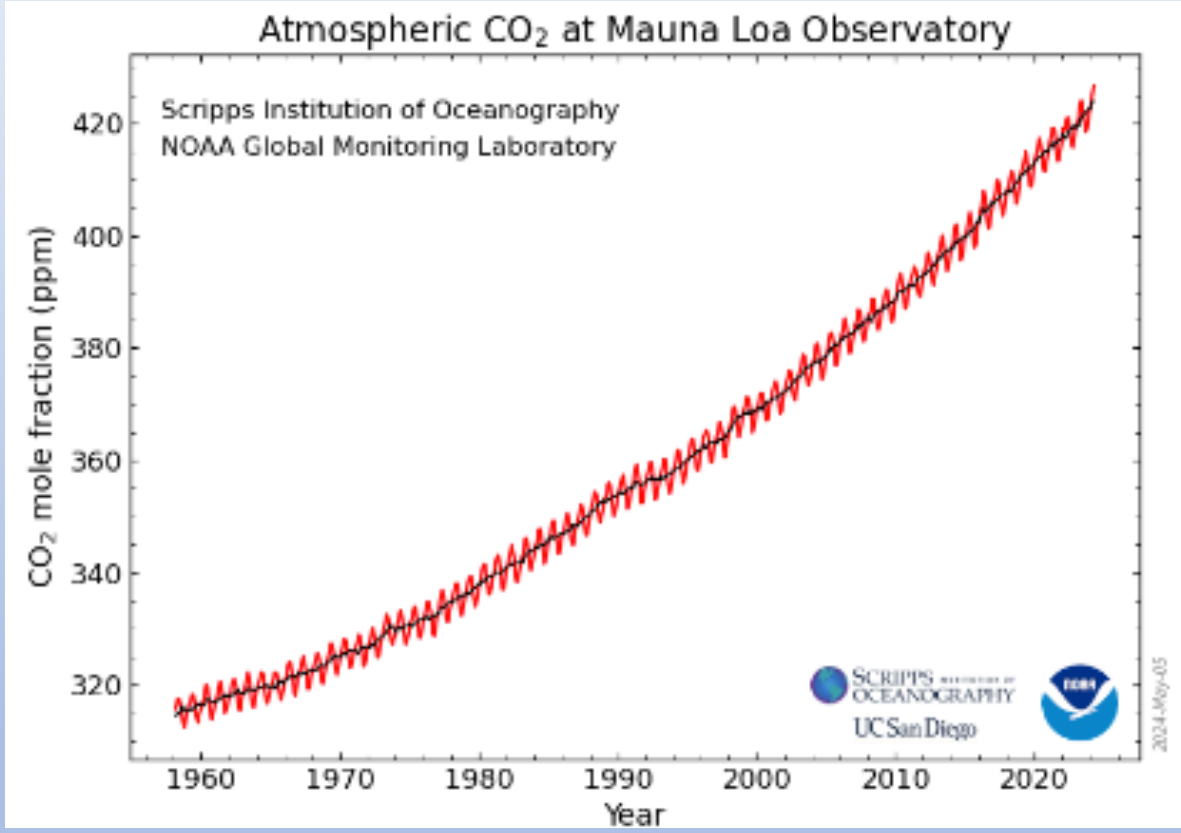
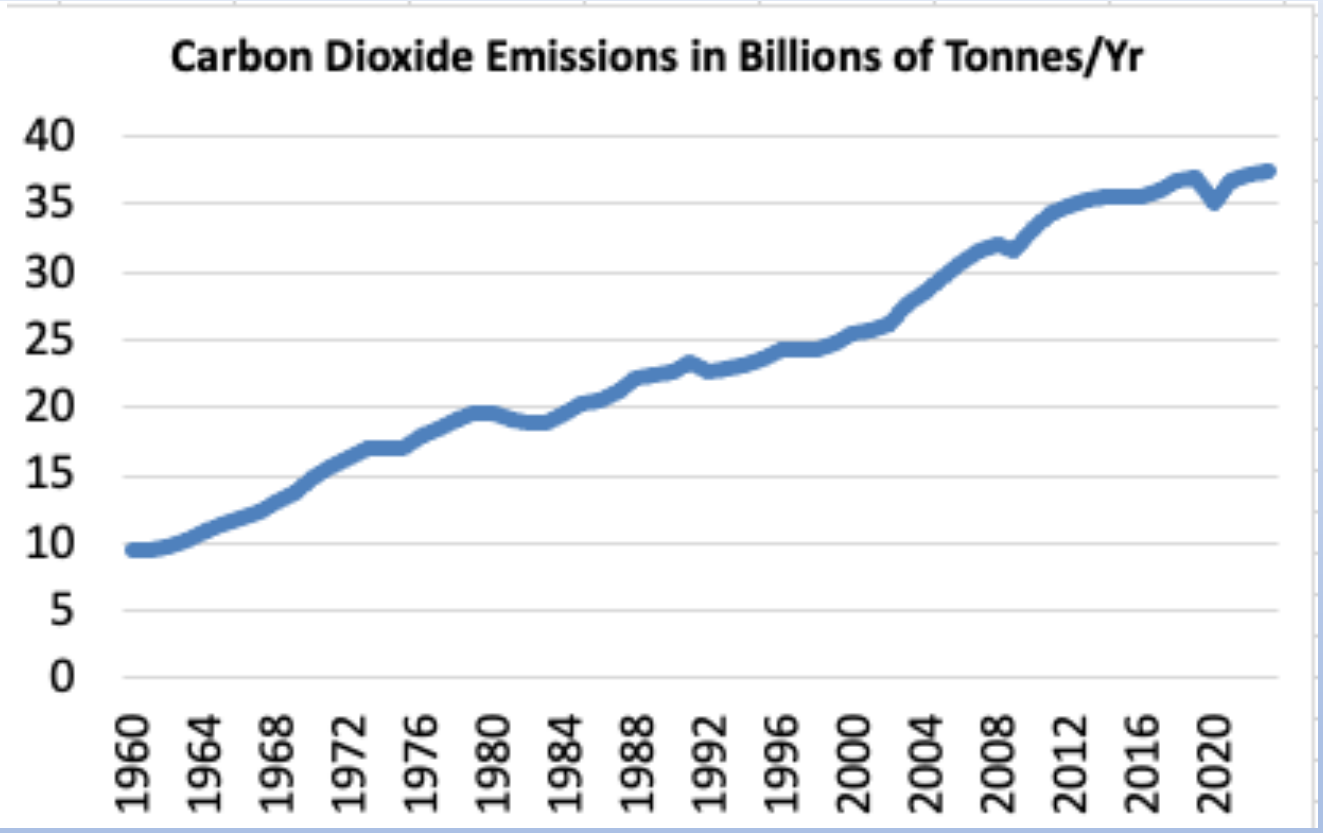
# $CO_2$ Levels in the Atmosphere Keep Rising at Increasing Rate




Monthly Average $CO_2$ level at the Mauna Loa observatory in Hawaii

CO2 Emissions in billions of tonnes/Yr by the Global Carbon Project via Statista.com

# UN Statement on Need for Climate Action

UN Secretary-General, António Guterres said:

"Our world needs climate action on all fronts — everything, everywhere, all at once"

# The Amount of Geologic Hydrogen (a.k.a. Natural, White, Gold and Orange Hydrogen) Available Around the World

- A US Geological Survey study reveals the Earth holds over 5,000,000,000,000 (trillion) tonnes of geologic hydrogen.
- There is already a commercial site producing Geologic Hydrogen near Bourakébougou, Mali. It started production in 2012.
- Geologists have reported that they have found or soon expect to find geologic hydrogen reserves in various locations including Canada, US, Australia, France, Albania and Spain.
- Geologists Are Predicting a Natural Hydrogen "Gold Rush" (Article by Zero Hedge on Feb 21, 2024)

# Growth in Extracting Geologic Hydrogen

The progress in extracting hydrogen directly from the earth is significant. Given below are some examples:

- Gold Hydrogen Limited has indicated that they can produce geologic hydrogen for approx. US$0.66 per kilogram.
- Koloma In the US recently raised $330 million in 2024 for developing Geologic Hydrogen projects.
- Chapman Hydrogen and Petroleum Engineering is developing a geologic hydrogen project in northern Ontario.

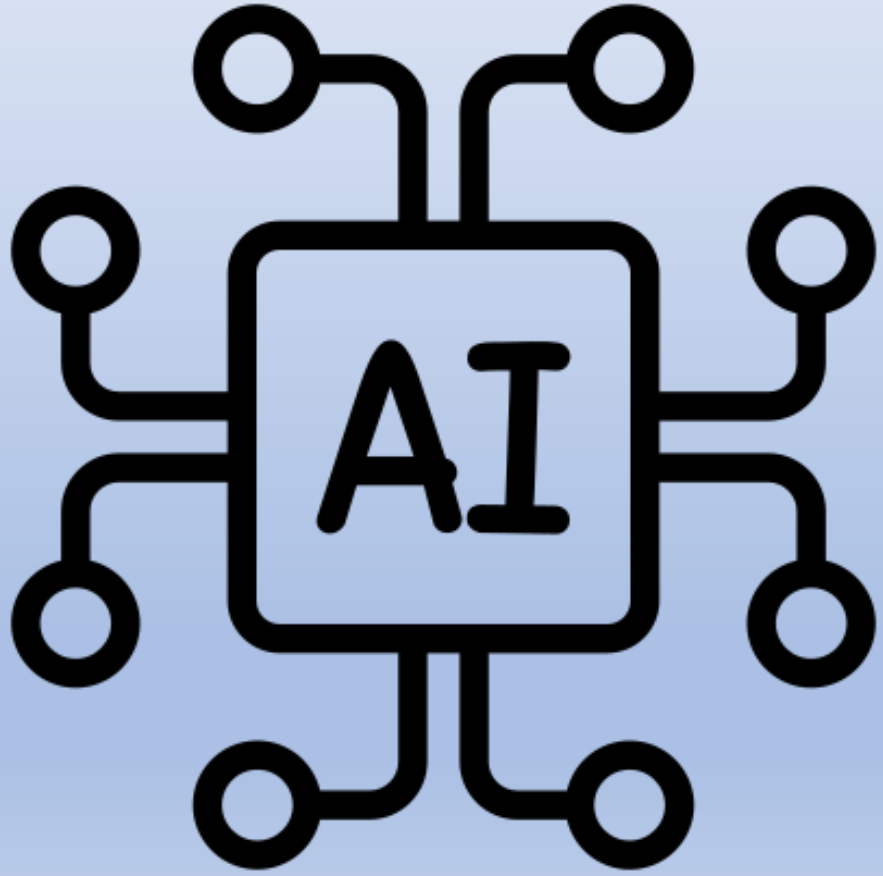
# Utilize AI to Analyse Available Data to Identify the Best Areas for Geologic Hydrogen – Part 1

To accelerate the process of finding Geologic Hydrogen, artificial intelligence (AI) services can be used to review available data relating to land resources around the world, including data from satellites, to determine an initial set of areas that could then be reviewed further by experts to determine the best locations for exploration. When doing so, these services can analyze available data for many parameters including the following:

- Best geological formations.
- Proximity to a potential electrical grid connection.
- Proximity to markets including population centres.
- Access to adequate roads to transport equipment, supplies and hydrogen.
- Data available from surveys including gravity, magnetic, seismic & geochemistry.

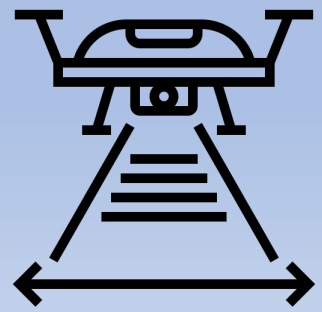
# Companies that Can Utilize AI to Identify the Best Areas for Exploring for Geologic Hydrogen – Part 2

- There are now multiple companies that are specializing in using Artificial Intelligence (AI) to identify the best areas for exploring for Geologic Hydrogen.
- One of the companies that is specializing in this area is Rubicon Exploration. Along with AI, they have developed and utilize additional technologies to help explore for Geologic Hydrogen.



# Aerial Natural Hydrogen Detection with Raman LiDAR Technology – Part 3

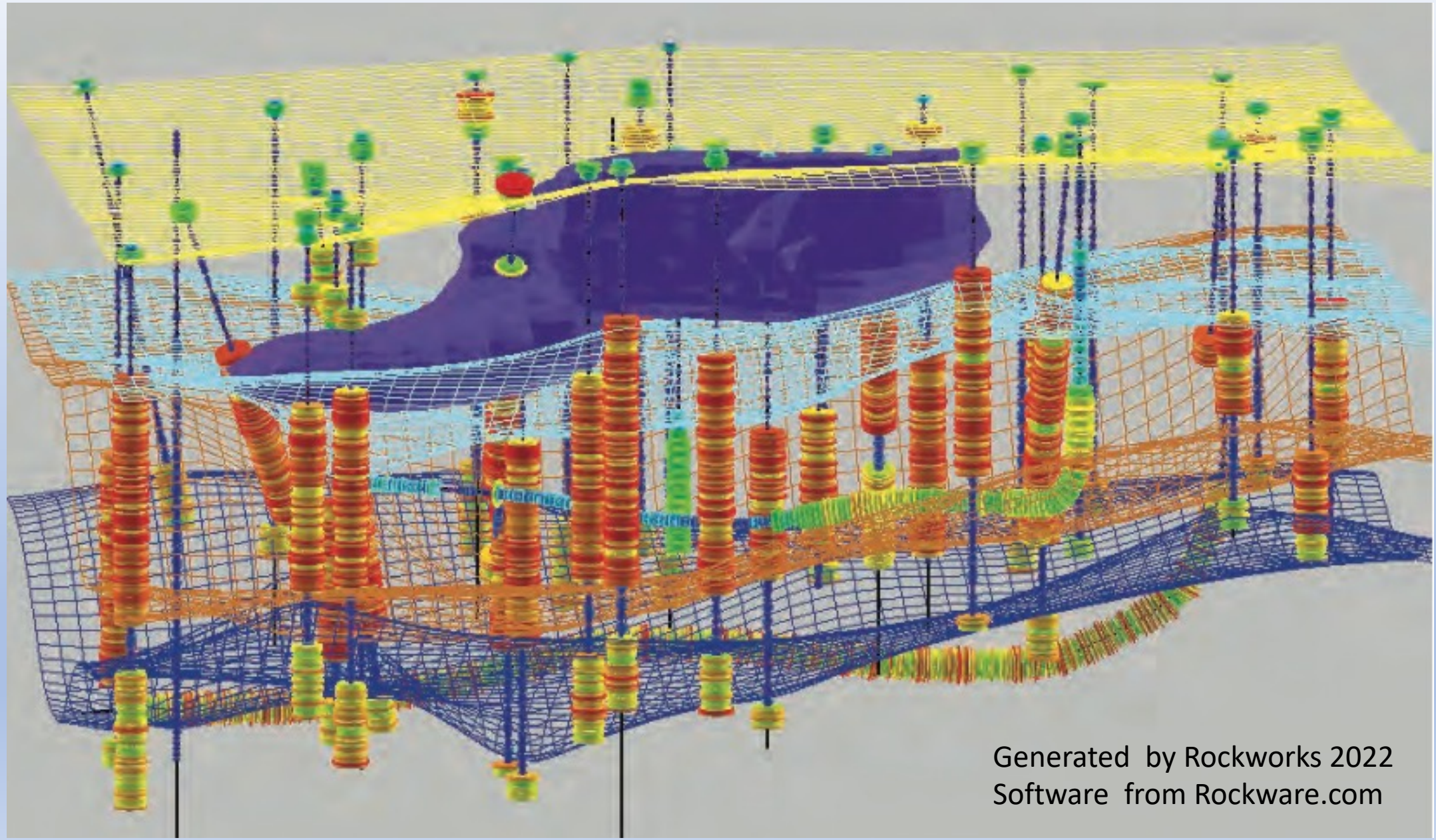
- Once AI has identified the best areas for exploring for Geologic Hydrogen in a selected country, these areas can be surveyed with a technology to help identify the best locations to explore for Geologic Hydrogen.
- This technology is called Raman LiDAR (Laser Light Detection and Ranging) and it can detect hydrogen at a distance.
- Xcalibur Smart Mapping is now in the process of commercializing this LiDAR technology.
- As a result, combining this technology with a small airplane or drone enables a low-cost way to find hydrogen that is seeping out of the ground.



# Visualize the Results from AI Data Analysis and Invite Experts to Identify the Best Locations – Part 4

- Utilize AI services to create data files that can be viewed in a selected data visualization software from available data including from LiDAR, gravity, magnetic, seismic and geochemistry surveys as well as borehole logs.
- Import all the relevant data into the selected data visualization software.
- Invite a team of experts including geologists to view the data in visualization software to identify the best locations to start exploring for Geologic Hydrogen.

# Example Visualization of Geological Data



# Utilize AI to Analyse Available Data to Identify the Best Areas for Geologic Hydrogen in the World

To help identify the best areas to explore for Geologic Hydrogen around the world, we recommend the following information be generated with the assistance of AI services:

- Using AI services, analyze accessible land areas of the world to determine an initial set of 10,000 areas that can be surveyed from the air and reviewed by experts to determine the best 2,000 locations for exploring for Geologic Hydrogen around the world. To make this information easy to view in Google Earth Pro, create a KML file containing this information for each country or countries in a region such as West Africa.
- Create additional KML files that includes data relating to each parameter identified in previous slides that can also be imported into Google Earth Pro.
- Invite countries with best areas to explore for Geologic Hydrogen to create an open bidding process to encourage companies to start exploring for this hydrogen. In addition, inform the private sector about the range of available technologies that can help them do so.

# Improving Methodologies and Technologies for and Extracting Geologic Hydrogen

- As a result of the collaboration of many researchers in universities and companies around the world, considerable progress has been made in developing the best ways for exploring for and extracting Geologic Hydrogen.
- Since the Geologic Hydrogen industry is relatively new, much more progress can and should be made.  Therefore, to further reduce the cost of exploring for and extracting Geologic Hydrogen, increased investment should be made in research and development to improve methodologies and related technologies for these activities.
- These improved methodologies can be incorporated into AI models to make them more effective in identifying the best locations to explore for Geologic Hydrogen.

# Accelerate Action by Creating Awareness of Business Opportunities Relating Geologic Hydrogen

- Create an increased awareness of the current “Gold Rush” amongst a relatively small number of companies that are searching for Geologic Hydrogen to pique the interest of many more companies, investors and economic development agencies.
- Share results generated from AI data analysis with governments, industry and investors.
- Create awareness how additional hydrogen can be produced in iron-rich rock formations (referred to as Orange Hydrogen).
- Create awareness of how geothermal energy can often be obtained from the same wells that are extracting Geologic Hydrogen.
- To further increase interest in Geologic Hydrogen, create awareness of how this hydrogen can be utilized by proven technologies to produce a range of valuable products such as reliable electricity, commercial-grade hydrogen and methanol.

# Steps to Estimate Amount of Geologic Hydrogen Available in a Selected Location

Given below is an outline of a program to explore for Geologic Hydrogen in a selected location:

- Phase 1: Make a thorough review of the places to explore by studying data and geological maps in the selected areas. Then select the best locations to start sampling soil and fluids.
- Phase 2: Complete laboratory testing of samples from selected locations.
- Phase 3: Complete initial drilling and testing the wells for hydrogen.
- Phase 4: Perform Full Field Development by drilling sufficient wells for delivering Geologic Hydrogen gas to market.

# Geologic Hydrogen Bonus: Helium

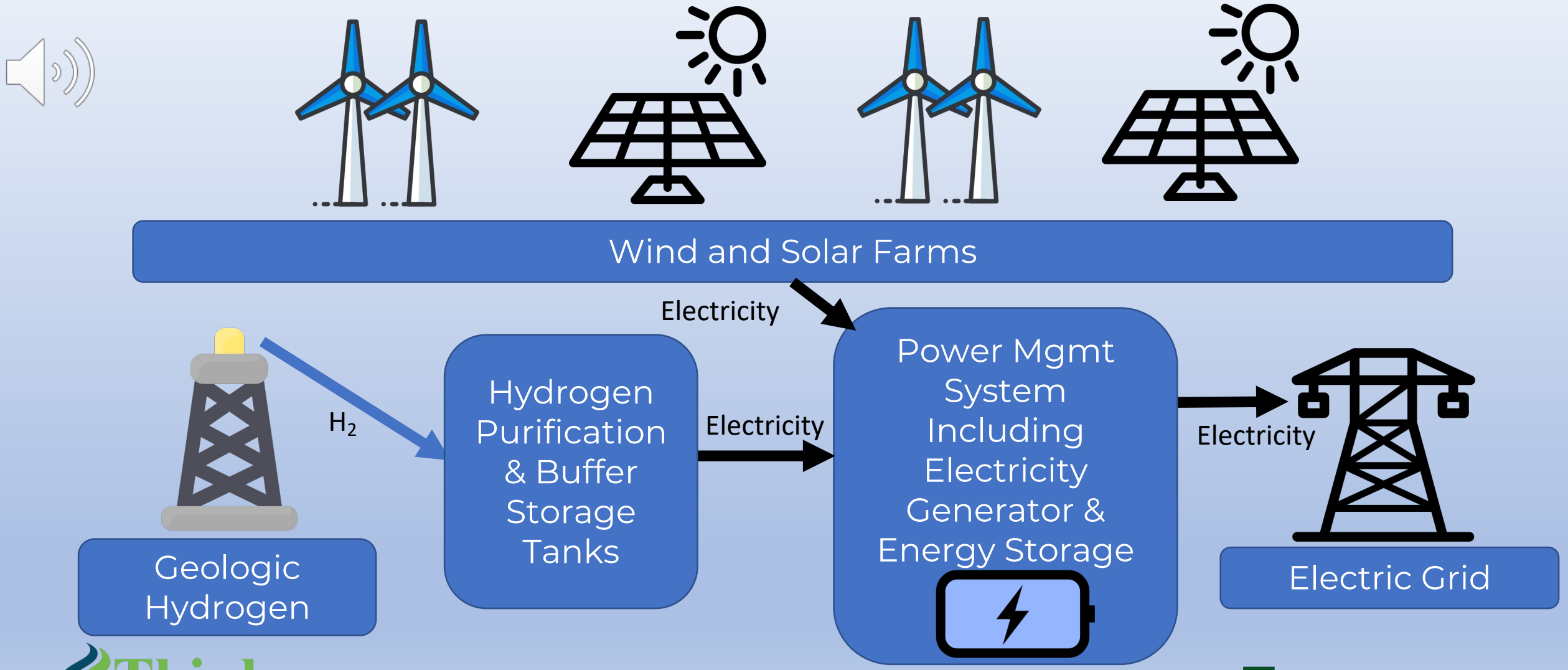
- Helium, which is high value commodity, is often found along with Geologic hydrogen.
- For example, Gold Hydrogen in Australia estimated that they found approximately 41 billion cubic feet (BCF) of helium along with 1.3 billion kilograms of Geologic Hydrogen in the area they are exploring.
- The US Geological Survey reported that the price for Grade-A helium was approximately US$14/m3 ($0.39 per cubic feet) in 2023.
- At this price, 41 BCF of Grade-A helium would have a value of approximately US$16 billion dollars.

# Leverage Existing Initiatives to Promote Growth of Geologic Hydrogen Around the World

There are a considerable number of organizations and events focused on Geologic Hydrogen. Given below are some examples:

- Drilling for Hydrogen 2024 on September 11 & 12, 2024 at Houston Marriott West Loop, Houston, Texas.
- Natural Hydrogen Association of Australia's Conference from Oct. 29 to 31, 2024 in Adelaide Hills.
- H-Nat 2024 World Summit in Paris on Nov. 25 & 26, 2024.
- 2025 North American Helium and Hydrogen Conference on April 9 & 10, 2025 by The Rocky Mountain Association of Geologists.

# Combining Wind and Solar Farms with Energy Storage and Geologic Hydrogen to Produce Reliable Electricity

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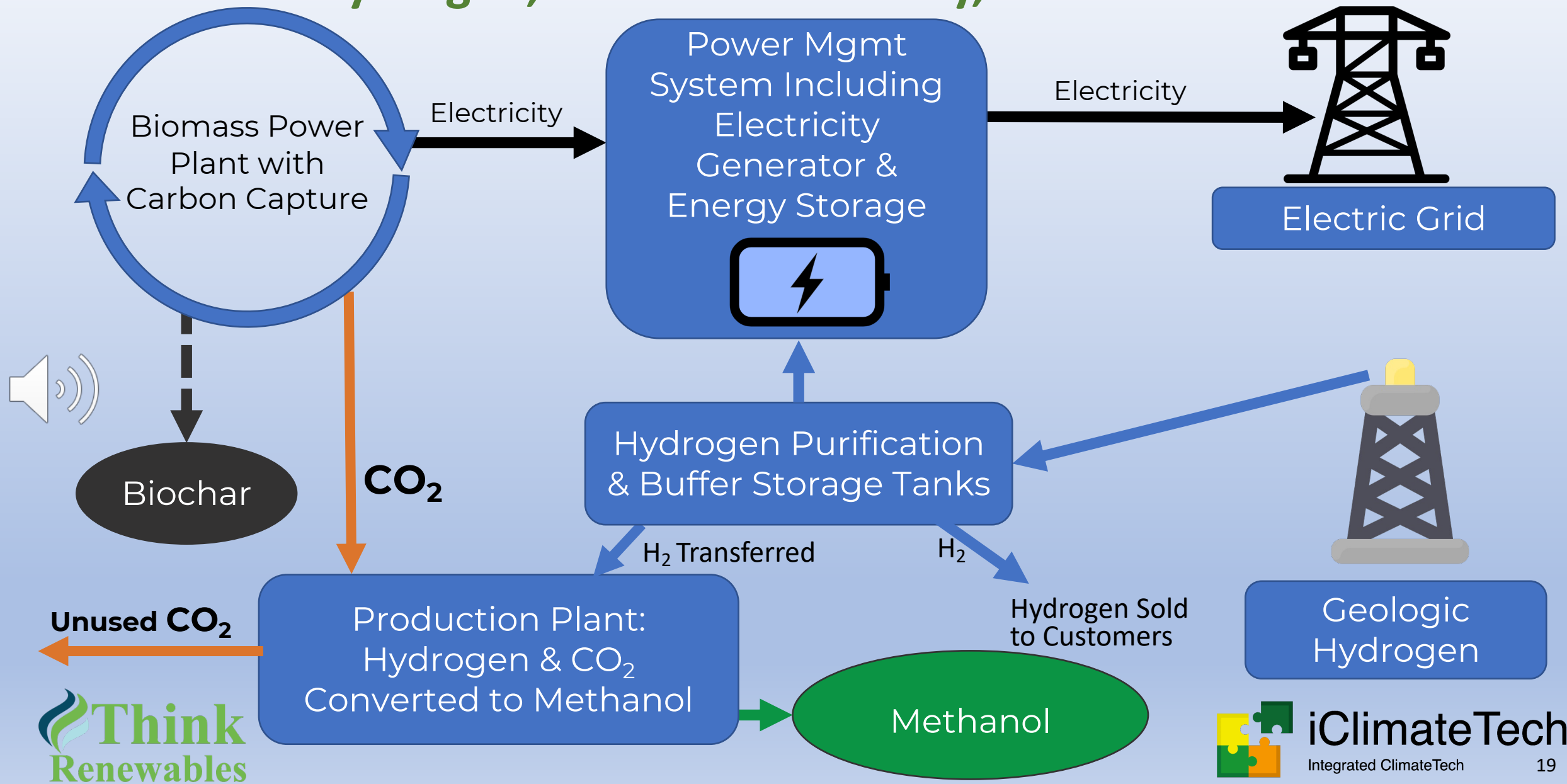
# Combining a Biomass Power Plant with Geologic Hydrogen to Generate 4 Valuable Products

Geologic hydrogen can be combined with a biomass power plant to produce reliable electricity, biochar, hydrogen and methanol as shown in a schematic on the next slide. A few key points:

- Methanol is currently being produced from hydrogen and $CO_2$ in several places around the world on a commercial scale.
- Geological Hydrogen would be transferred to buffer storage tanks, which would then be fed to an electricity generator and a methanol production system.
- The biomass power plant shown in the next slide produces electricity, biochar and $CO_2$.

# Combining Geologic Hydrogen and Biomass to Produce Commercial Grade Hydrogen, Reliable Electricity, Biochar & Methanol

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# Recycled Carbon Methanol

## Methanol Produced from CO2 and Hydrogen

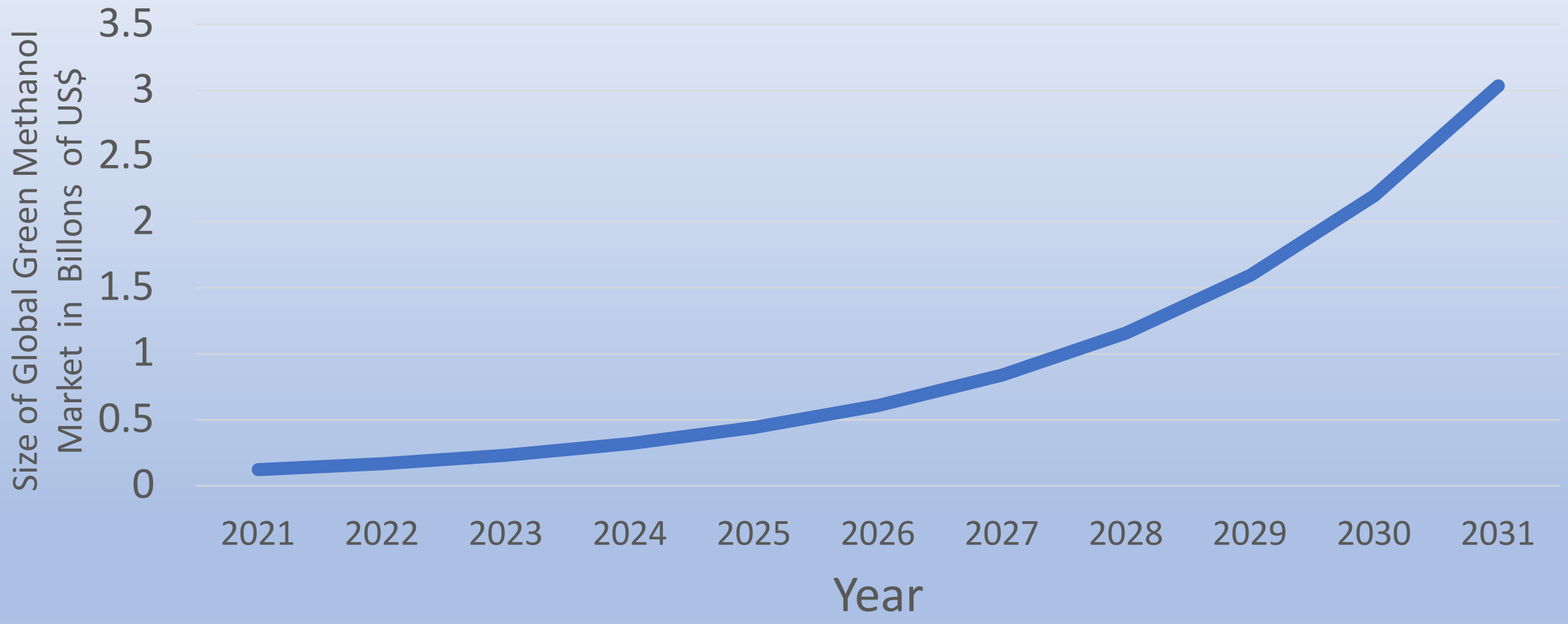
Example production plant that is being replicated:

- Carbon Recycling International has recently built a commercial-scale recycled carbon methanol plant in China and is developing several more in other countries.

Example buyer of renewable methanol (a sub-type of recycled carbon methanol):

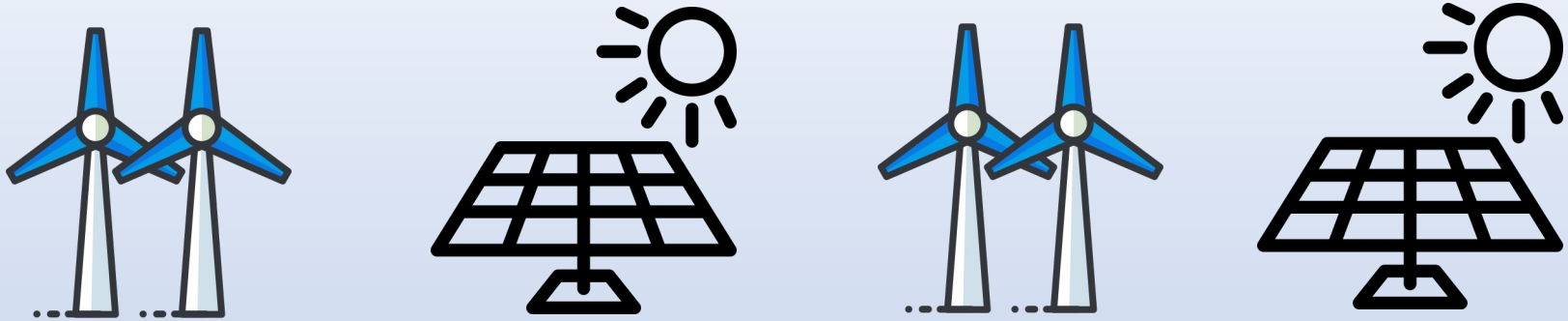
- The global shipping company, Maersk announced it is planning to purchase 730,000 tonnes/year of renewable methanol by end of 2025. This will effectively reduce the emissions by about 1,000,000 tonnes of $CO_2$ per year.

# Growth of Demand of Renewable Methanol




According to BIS Research, the global renewable methanol market is projected to reach US$3 Billion by 2031 from US$0.12 billion in 2021, growing at a CAGR of 40%.

# Combining Wind and Solar Farms with Energy Storage and Recycled Carbon Methanol to Produce Reliable Electricity



Wind and Solar Farms

Electricity

Recycled Carbon Methanol Storage Tanks

Methanol Fuel Cells, Generator or Turbine

Electricity

Power Mgmt System & Energy Storage

Electricity

Electric Grid

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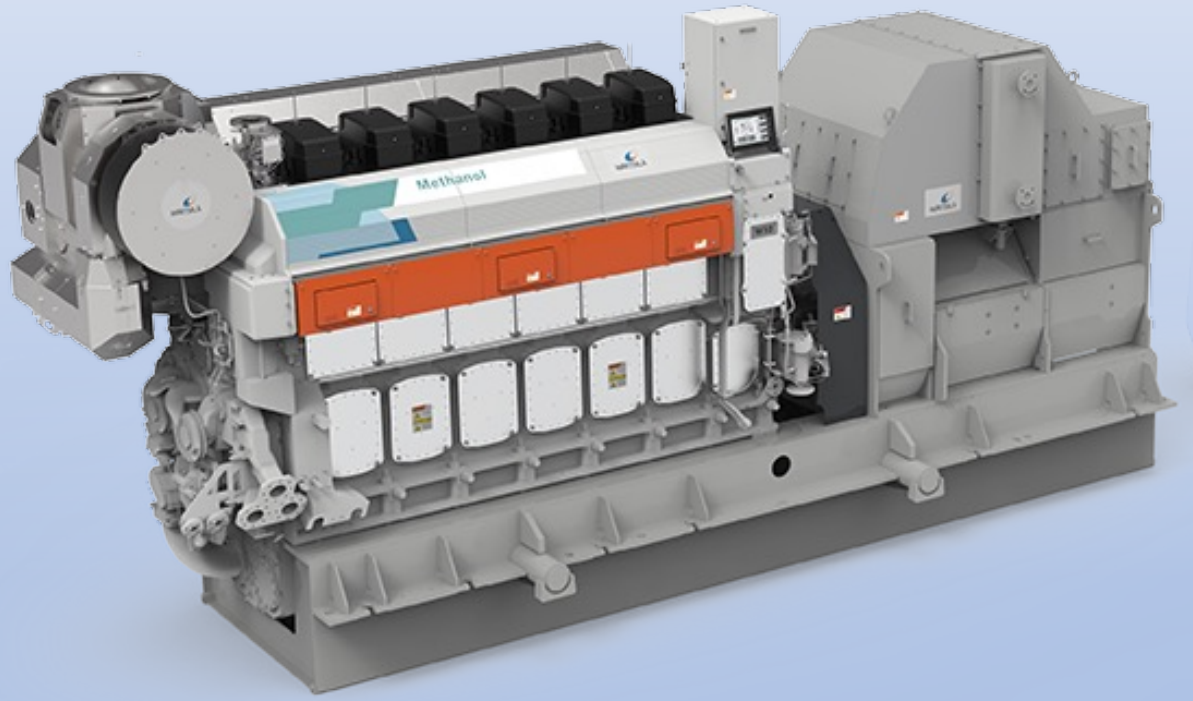
# Existing Internal Combustion Engines can Upgraded to Run on Methanol

- Existing internal combustion engines can be upgraded to run on methanol at a relatively low-cost. Kits can be purchased online to convert a gasoline engine to run on methanol.
- Converting diesel engines to methanol requires additional modification. One company that provides this service for large engines is Man Energy Solutions.
- As well, new engines can be purchased that are designed to run on methanol. For example, shown here is a methanol-fueled engine by Wärtsilä



# Methanol Can Power Remote Electric Vehicle Charging Stations

- Shown here is an example of a methanol powered remote electric vehicle (EV) charging station.

- Wind and solar energy can be added to this charging station to reduce the cost of the electricity.

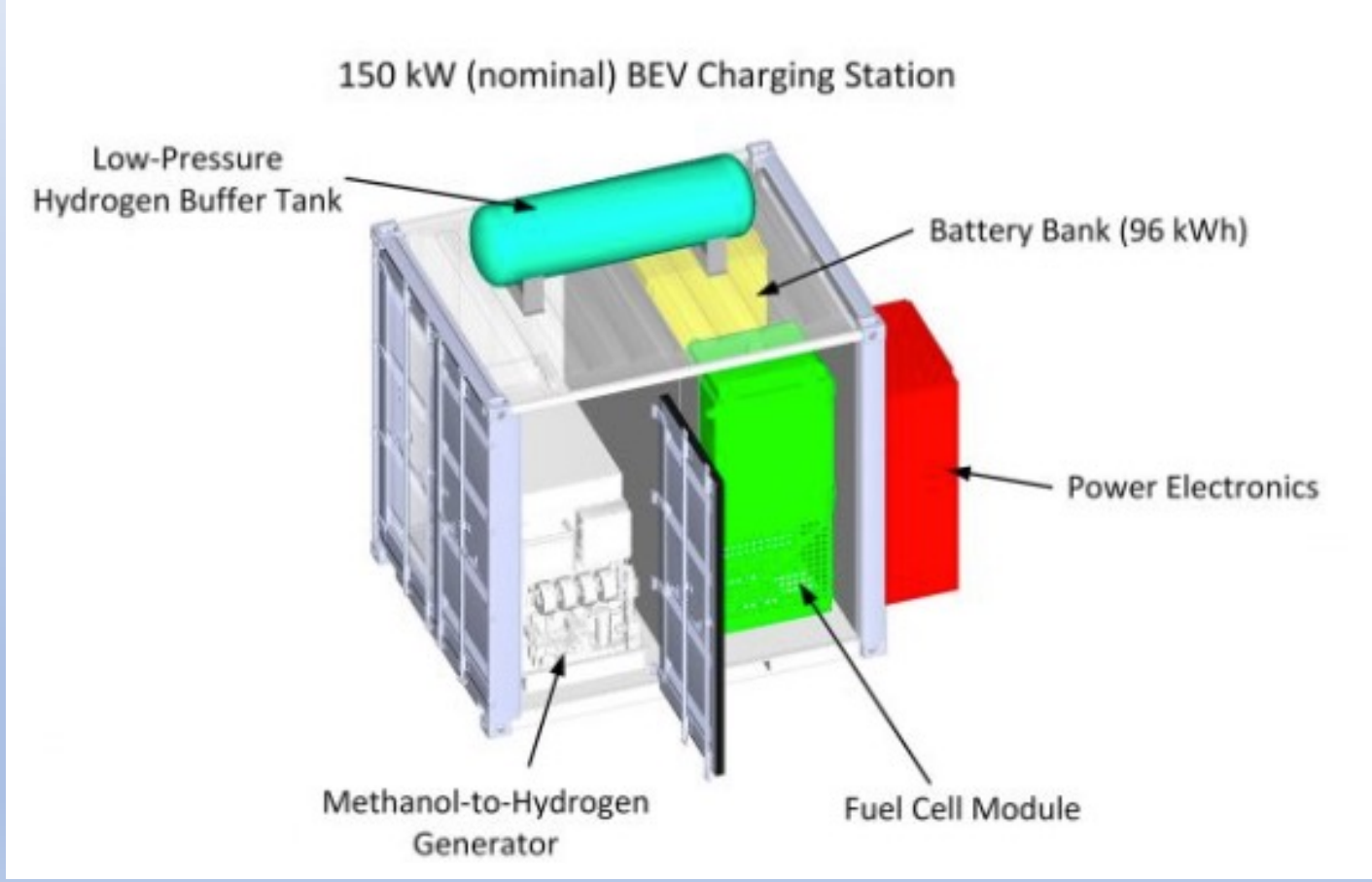



Image Courtesy of Element 1 Corp, Bend, Oregon

# Producing & Utilizing Ammonia from Geologic $H_2$

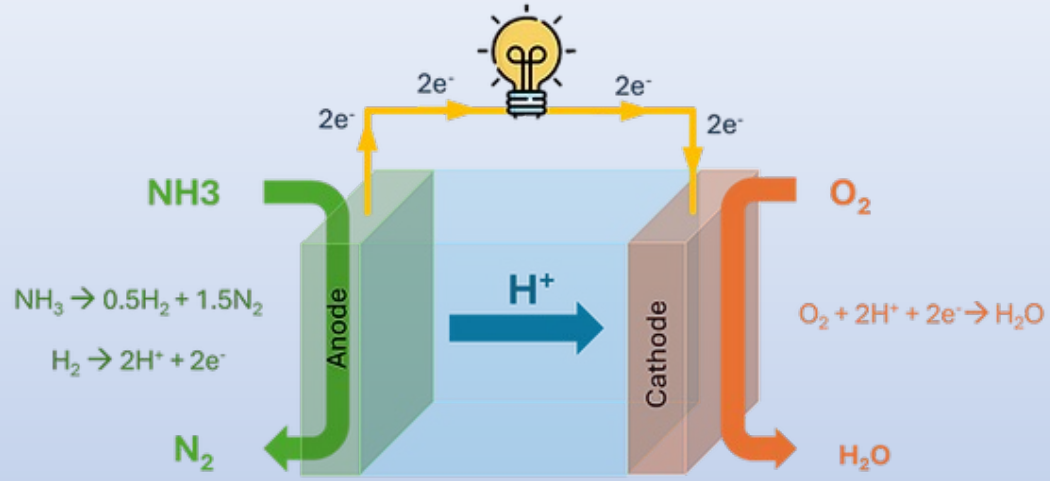
$$N_2 + 3H_2 \rightarrow 2NH_3$$

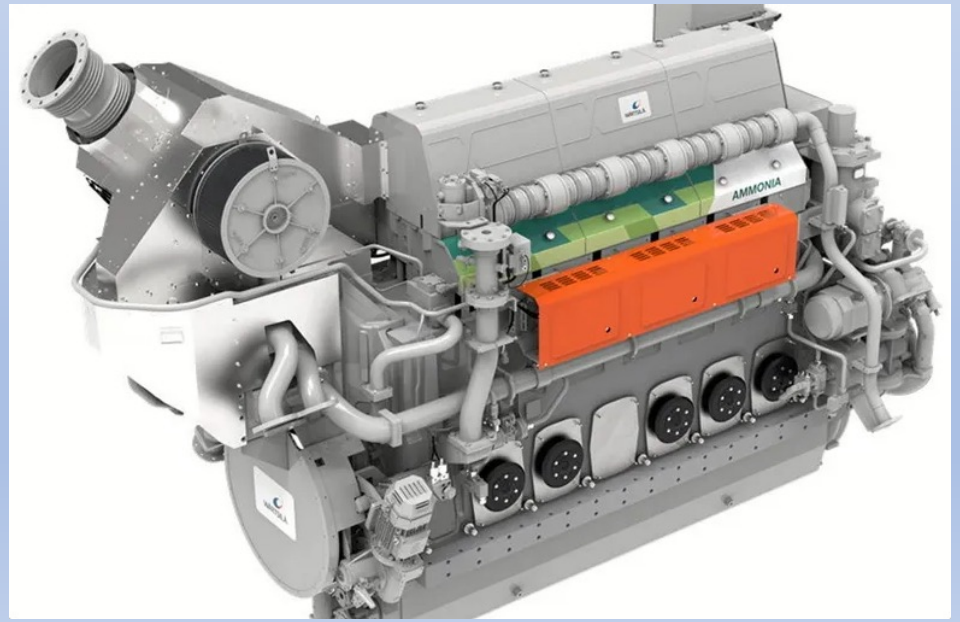
- A substantial amount of Geologic Hydrogen could be used to produce ammonia. For example, a research paper published in Sustainable Energy & Fuels reports that most of the nearly 180 Mt of ammonia produced globally every year are generated via reforming of natural gas (72%) or coal (26%), resulting in approximately 500 Mt of carbon dioxide.
- Eighty percent of the ammonia manufactured globally today is used in agriculture by farmers as a nitrogen fertilizer.
- Ammonia is used as a chemical ingredient in many industries including wastewater treatment, refrigerants and pharmaceuticals.

# Ammonia Powered Fuel Cells and Engines

- In addition to being used for fertilizer and as a chemical ingredient for industry, ammonia can be used as a fuel. Shown here are two devices that can be powered by ammonia.

- The first is a fuel cell and the second is an internal combustion engine (ICE) developed by Wärtsilä.



# Conclusions

- Based on rising global CO2 Levels, the total energy demand appears to be rising faster than renewable energy generation, which is creating an urgent need to accelerate generation of clean energy.
- The US Geological Survey has estimated that there is over 5 trillion tonnes of geologic hydrogen in the Earth.
- A portion of this hydrogen can be extracted and be used to generate electricity and create other valuable products such as methanol using proven technologies.
- Methanol can be used for many beneficial purposes including:
  - Powering cars, trucks, heavy machinery and ships.
  - Enabling renewable energy facilities to provide more reliable electricity.
  - Power remotely-located EV charging stations.
- As a result of the vast amount of geologic hydrogen available and that it can be utilized effectively with complementary technologies, it can play a key role in accelerating the global energy transition to a low carbon economy.

# Recommendations

- To accelerate the process of finding Geologic Hydrogen, AI services should be used to review available data relating to land resources around the world, to determine the best locations for exploration.
- To reduce the cost of exploring for and extracting Geologic Hydrogen, increased investment should made in research and development to improve methodologies and technologies for these activities.
- A global campaign should be implemented to create awareness of the huge economic opportunities relating to geologic hydrogen. This can include sharing with the public some key info generated from AI data analysis.
- To further increase interest in Geologic Hydrogen, create awareness of how this hydrogen can be utilized by proven technologies to produce a range of valuable products such as reliable electricity, ammonia and methanol.
- As the UN Secretary General has said, our world should take climate action on all fronts — everything, everywhere, all at once.

# *Thank you*

## For more info, see:

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