Facilitating a Hydrogen Fuel Cell Infrastructure in Support of Tactical Micro Grids®

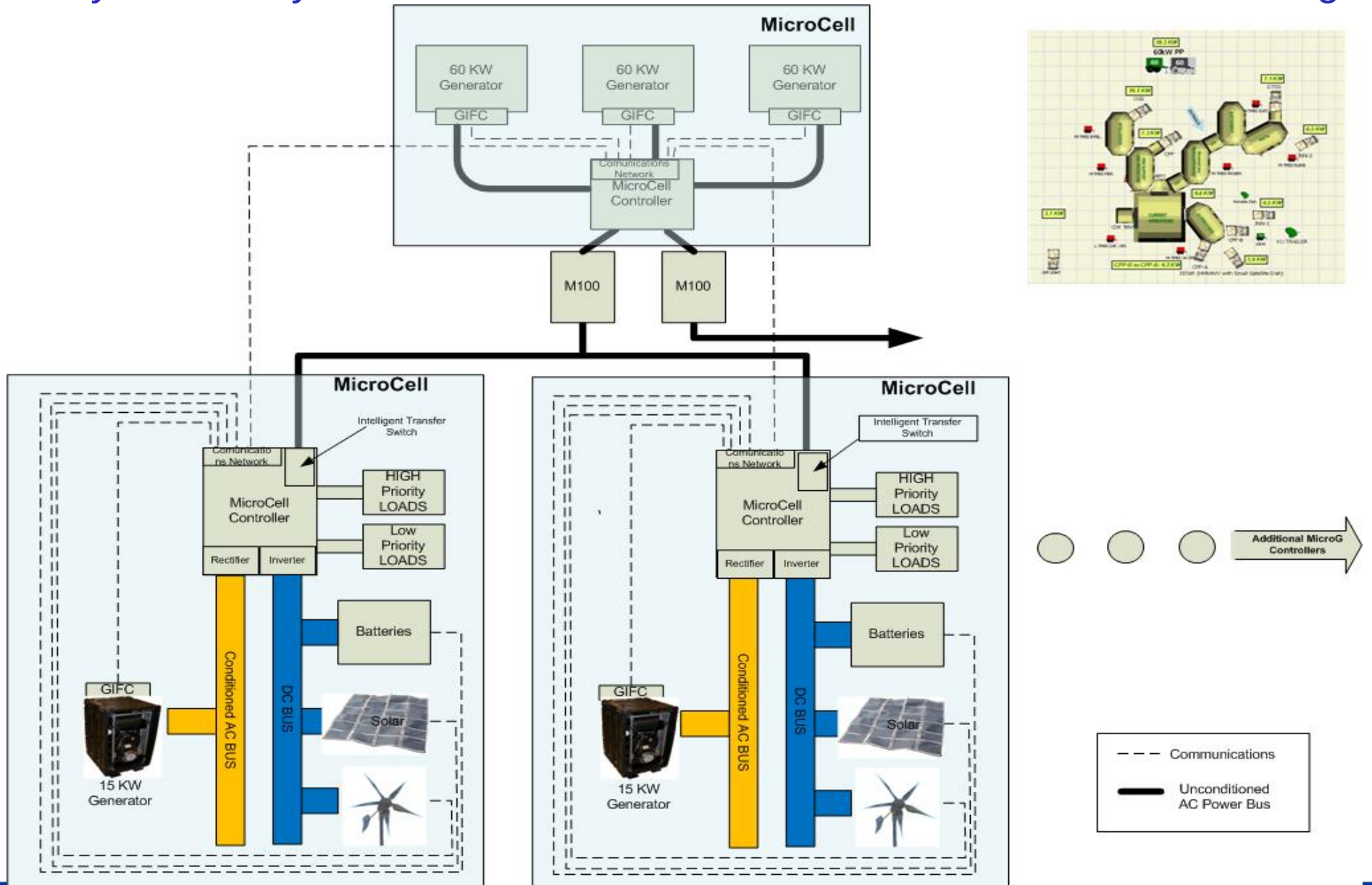
- Fuel cells are becoming more prevalent in micro-grids
- the lack of hydrogen infrastructure is impeding growth
- Base Facilitated Reformation(BFR) Is a potential solution

Topics Covered Here:

- Micro Grid Configuration
- Base Facilitated Reformation(BFR)
- Multiple Feedstocks
- Total Recovery System
- BFR Configurations
- Distribution Opportunities

H2 Infrastructure

System of Systems Architecture Based on Modular Micro Cell Design



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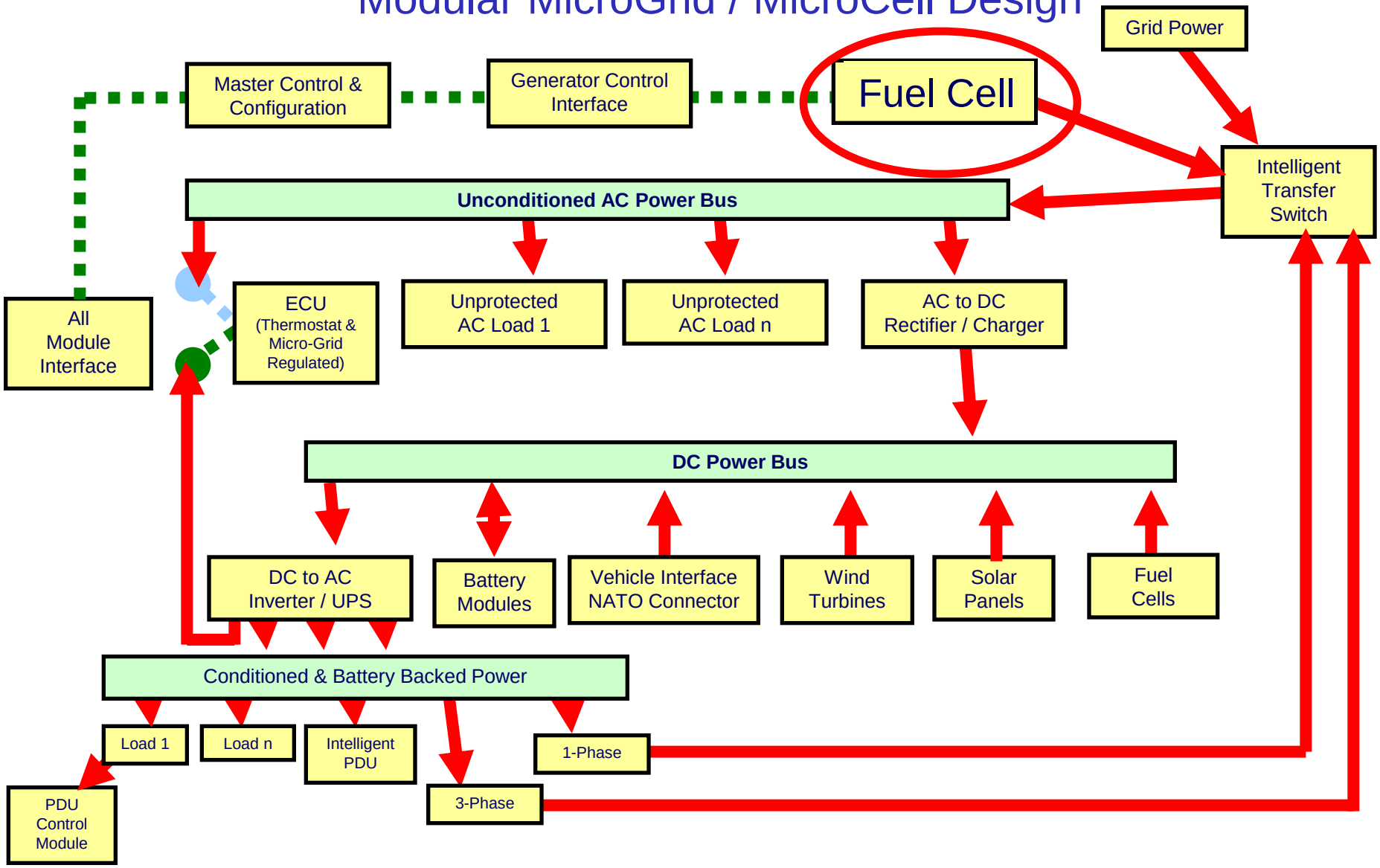
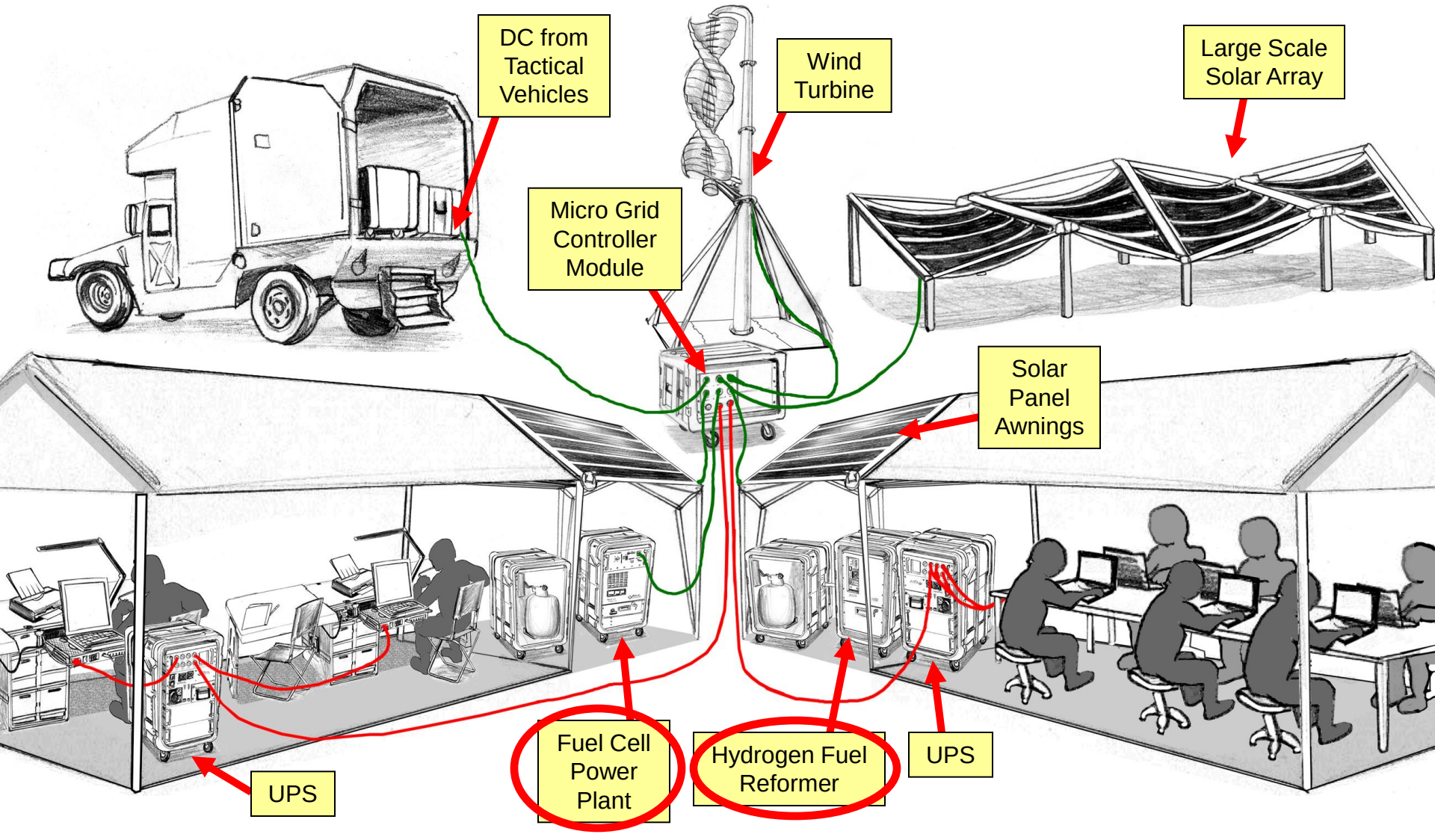
Military Eco Energy Micro Grid Installations

Modular MicroGrid / MicroCell Design



Hybrid Powered Base



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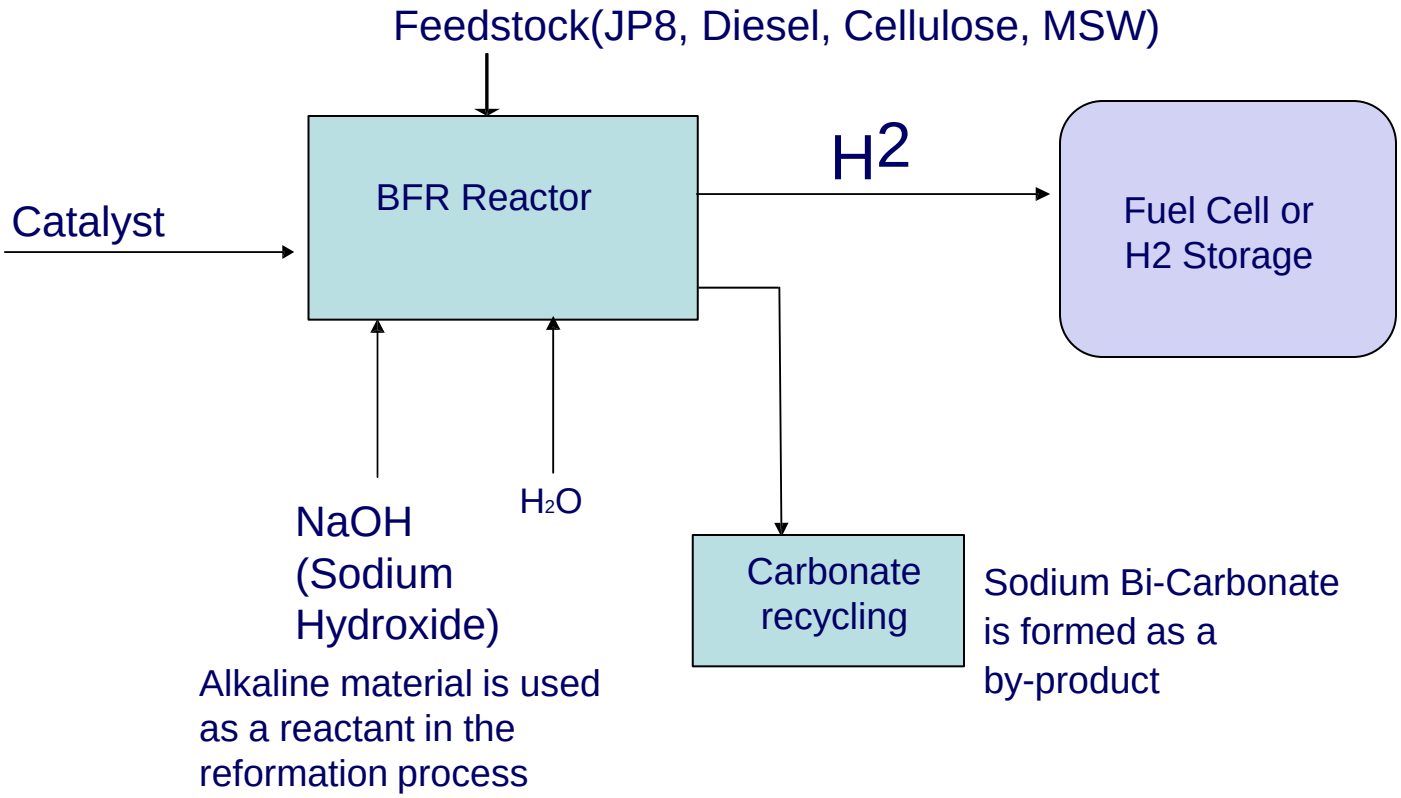
PROPOSED SOLUTION TO H2 INFRASTRUCTURE

Base Facilitated Reformation
Simple One Step, Energy Efficient Process to High Purity Hydrogen



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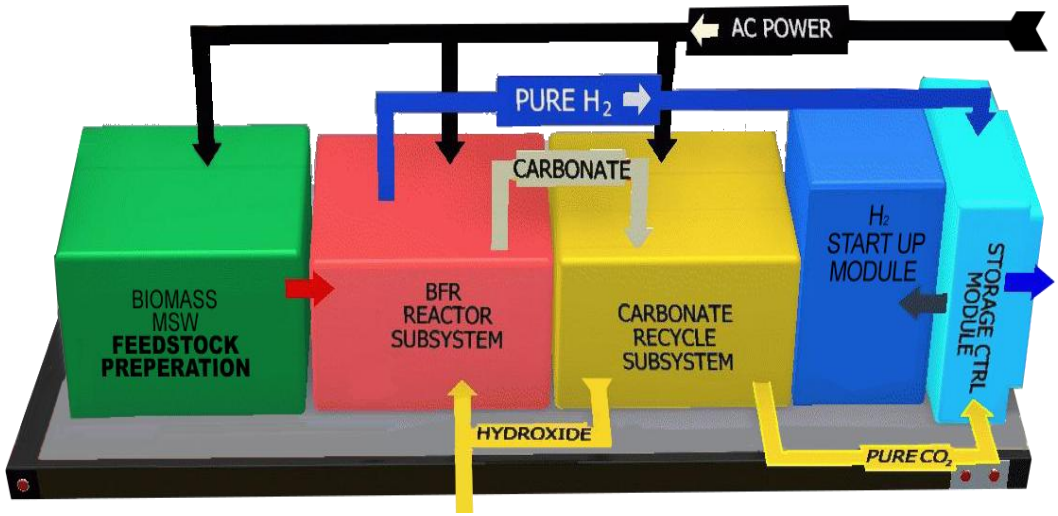
UNDERLYING TECHNOLOGIES

Base Facilitated Reformer (BFR)



This system is a low cost direct conversion of feedstock into pure hydrogen (H2) without producing greenhouse gas greenhouse gas emissions (no CO and CO2)

The BFR process is modular and scalable allowing hydrogen production near the point of use, minimizing transportation costs.

The H2 produced through this process is delivered directly to fuel cells or stored in vessels.

BFR ADVANTAGES

- One step reaction – making reformer design simpler
- Bio-waste / biogenic materials can be converted directly into H2
- No CO or CO_2 gases formed – Water gas shift and PSA not necessary
- Greener process – CO_2 sequestered as a carbonate (i.e. Na_2CO_3)
- Pure hydrogen is formed
- Batch or continuous operation possible
- Lower operating temperatures
- Can be used to reform variety of feedstocks, a major advantage.
- Minimizes / eliminates waste storage/transport
- Minimizes / eliminates the need for waste incineration
- Modular and scalable, allowing for application at point of H2 use

Examples of Renewable and Non-Renewable Feedstocks Successfully Reformed into Hydrogen by BFR Process



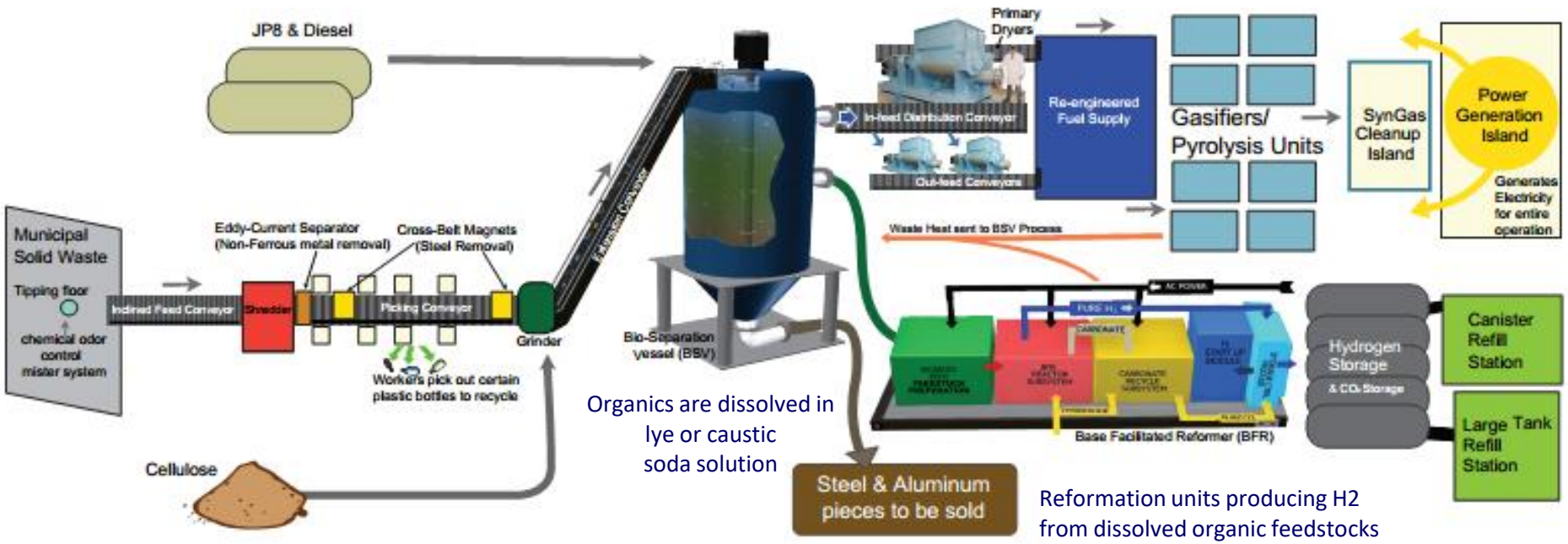




Fossil Fuels: JP8, Diesel, Methane (Natural Gas, Landfill Gas, Bio-Gas, Flare Gas), Coal
Municipal Solid Waste (MSW): Paper Products, Wood, Food and Yard Wastes
Agricultural Solid Waste (ASW): Animal, Crop and other Agricultural Organic Wastes
Food Industry Waste (FIW): Food Processing, Meat Processing and Food Service Wastes, i.e. Fryer Oils, Potato Peels
Biomass: Grass, Algae, Sawdust, Woodchips, Corn, Cellulose
Alcohols: Methanol, Ethanol, Crude Ethanol, E95, Ethylene Glycol, Glycerol
Sugars and Starches: Glucose, Fructose, Starch (Corn Starch, Potato Starch)

INTEGRATING BFR INTO TOTAL RECOVERY SYSTEM

Dryer units producing engineered fuel from plastics and other undissolved feedstocks

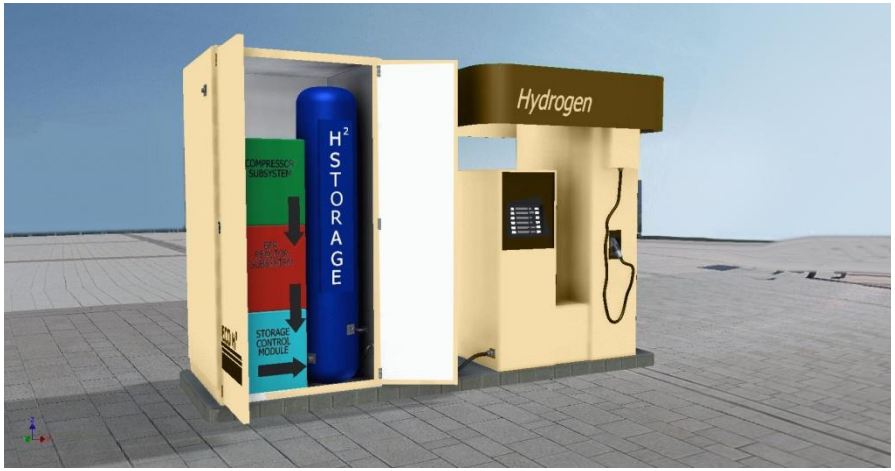


Organics are dissolved in lye or caustic soda solution

Reformation units producing H2 from dissolved organic feedstocks

H2 Infrastructure

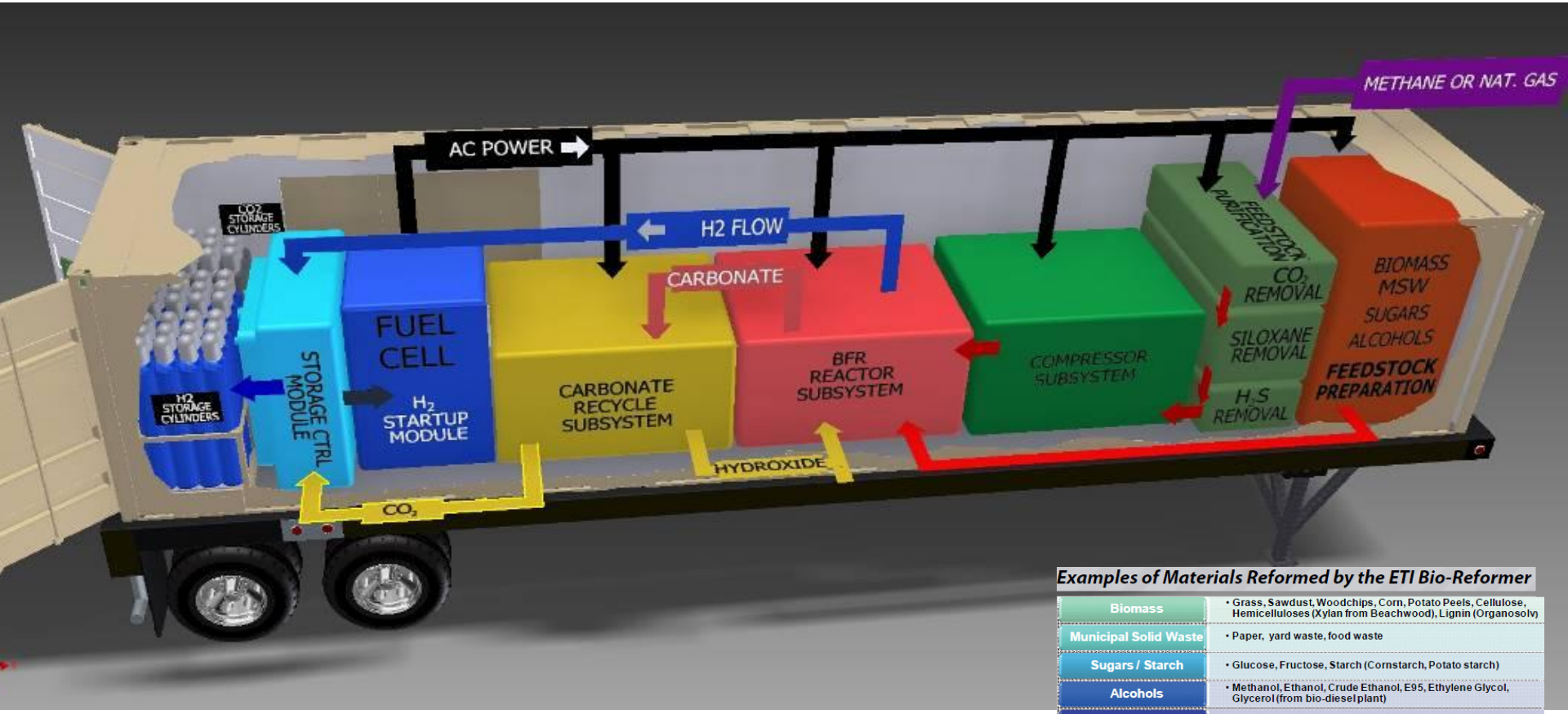
FOB Point of Use



Depot Point of Use

Scalable up to 2000 Kg of H2 Per Day

H2 Infrastructure



Examples of Materials Reformed by the ETI Bio-Reformer

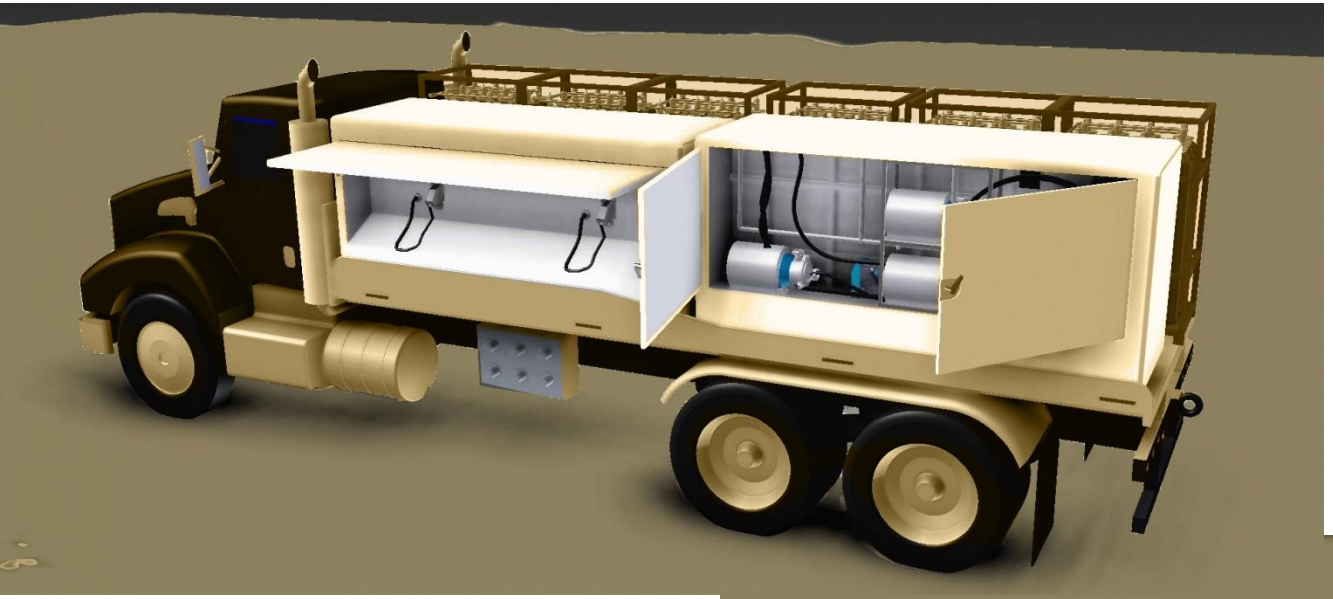
Biomass	• Grass, Sawdust, Woodchips, Corn, Potato Peels, Cellulose, Hemicelluloses (Xylan from Beachwood), Lignin (Organosolv)
Municipal Solid Waste	• Paper, yard waste, food waste
Sugars / Starch	• Glucose, Fructose, Starch (Cornstarch, Potato starch)
Alcohols	• Methanol, Ethanol, Crude Ethanol, E95, Ethylene Glycol, Glycerol (from bio-diesel plant)
Fossil Fuels	• Methane, Coal

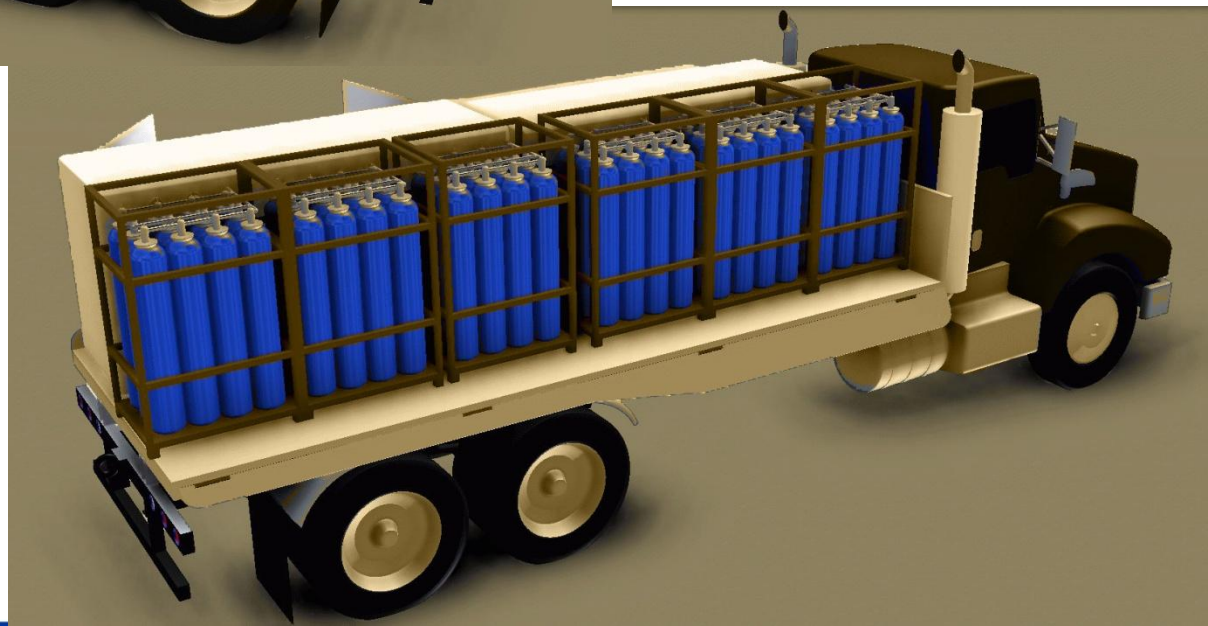
H2 Infrastructure

Distribution of H2 Storage Module to Mobile Refueling Vehicle & Permanent Station

H2 Infrastructure

Specialized H2 Distribution/Fueling Trucks to deliver H2 to other forward locations





BFR BYPRODUCT DISPOSAL

What to do with carbonate byproducts?

- Recausticize back to NaOH (common name: lye or caustic soda) for use as makeup to the input of the process

- Disposal of carbonate in block form

SUMMARY

- Our Base Facilitated Reformation (BFR) process has been successfully demonstrated using a wide variety of renewable feedstocks.
- Reformation of municipal and agricultural wastes, biogases and other organic materials produces clean energy, helps solve environmental issues.
- Using the Total Recovery System can convert over 80% of waste to useful energy.
- BFR approach solves fuel cell H2 infrastructure issues
- Scalable technology allows application at FOB, Depot & support facilities.
- H2 can be utilized directly or stored
- Flexible feedstocks including, JP8, Diesel, MSW and Cellulose,

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