



20.11.25

Low-Emission & Low-Cost Hydrogen
from Methane Pyrolysis

Natural Gas & Hydrogen ? Win Win !

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PyroH2

Industry transition to clean fuels

Heat & Power

Heavy Transport

Remote Locations

Data Centers

Energy Storage

.....

The Challenge

(2025 - 2050)



Transition Drivers System

- * *Shares*
- * *Markets*
- * *Politics*

Board

- * *Environmental Awareness*
- * *PR /Image*
- * *Capital markets*

- * *Profits*
- * *Investment*
- * *Attention*

Management

- * *Local regulation*
- * *Markets regulation*
- * *Finance*

- * *Change*
- * *Risks*
- * *Permits*
- * *Safety*

Site

- * *Attention*
- * *Secured supply*
- * *Asset management*

- * *Change*
- * *Safety*

Field

- * *Unionized labor*



Transition Phase Challenges:

- Strategic
- Cost of Fuel
- Security of supply
- Infrastructure
- Capex
- Opex

Strategic:

- Available national resources (Natural Gas)
- Mature/limited infrastructure (Piping /Grid)
- Land (Limited land resources)
- Regulation (🤔)
- Secured supply (Sites energy self-sufficiency)

Cost of Fuel:

Normalized cost should reflect:

- Cost of energy (total)
- Cost of storage (H₂&CO₂)
- Cost at consumption point
- Opex (O&M)
- Capex (“cost of money”)
- Other (site specific)



	Grey H ₂	Blue H ₂	Turquoise H ₂	Green H ₂
Feedstock	Methane	Methane	Methane	Water
Tech	SMR	SMR + CCS	Pyrolysis	Electrolysis
Emissions	High-CO ₂	Medium CO ₂ : upstream + capture leakages	Low CO ₂ : upstream only	CO ₂ free (only w/ renewables)
Price	\$1-1.5/kg	\$2-3/kg***	\$1.5-4/kg**	>\$8 /Kg***
Utilizing existing infrastructure?	Yes, Established	No, Carbon storage reservoirs constraints	Yes, utilizing NG infrastructure & produced at consumption point	No, Lack of storage and transport, renewables; high costs of electrolyzers



Security of supply:

- Availability
- Backup fuel
- Seamless switch between fuels

(delivery system to site)

(availability on site)

Infrastructure:

- Availability
- Maturity

(Current vs. Required)

(available to/on site)

Capex:

- Initial investment
- Expansion costs
- Equipment life span

(“cost of money”/economy of scale?)

(through transition period)

(through transition period)

Opex:

- Power/Fuel
- Peripherals
- Maintenance
- **Storage**

(comprehensive costs)

Transition Enabling Prerequisites:

- Economically feasible
- Phased
- Expandable
- Secure / Safe
- Managed risks

The Proposed Solution

- Methane (Natural Gas) as the resource (and actual storage)
- Utilizing existing, secure NG distribution (and site infrastructure)
- H₂ supplied “just in time” (no storage)
- Adaptable fuel mix (NG/H₂) (for phased transition)
- Small scale feasibility (tech. and econ.)
- Small footprint (unit proximity)
- Carbon sequestered as Graphite (**not a liability – an Asset**)

Bottom Line

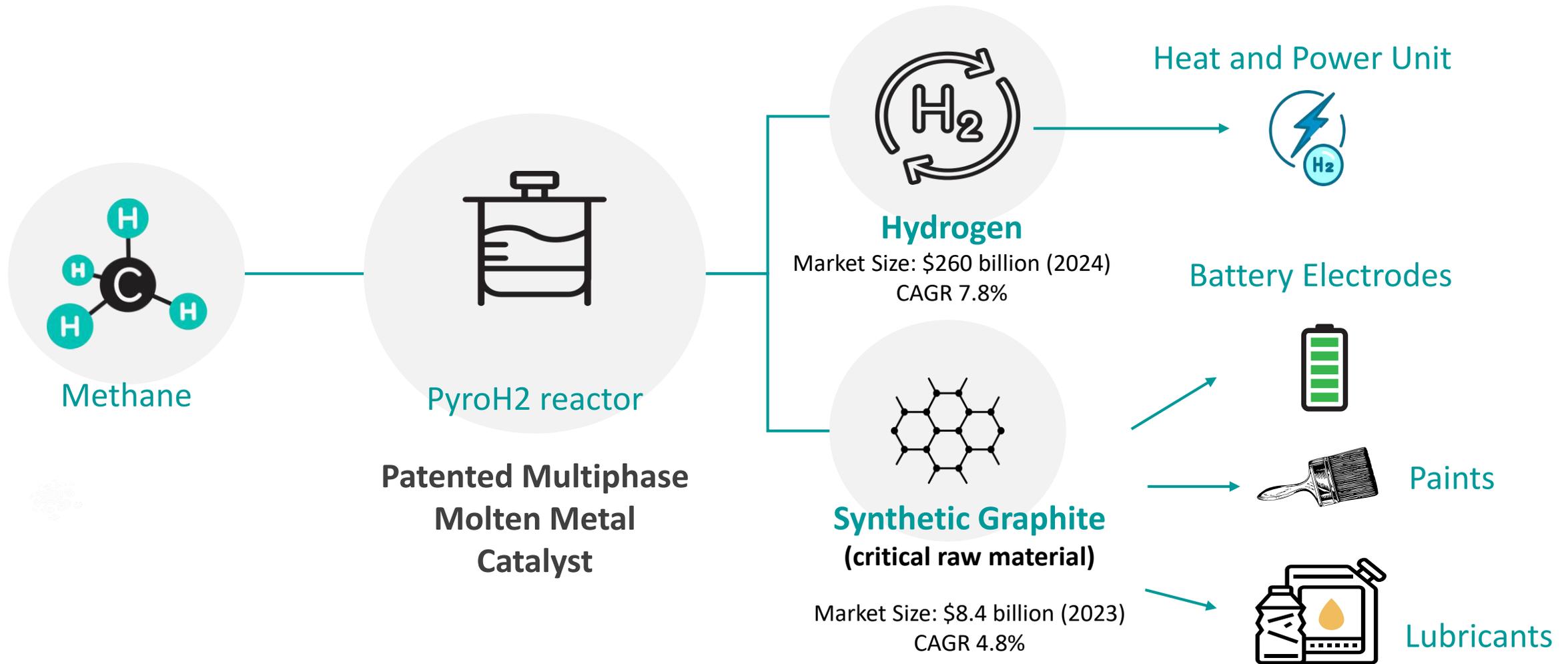
- **Processed Carbon MUST have commercial value**
- **Technology MUST allow for distributed H₂ production**
- **Systems MUST be expandable**

Introduction to PyroH2

- Breakthrough *Pyrolysis* technology
- *Multiphase* molten metal *catalyst*
- *Cost effective*, minimal risk transition
- Vertical, *small footprint* reactor
- Generic catalyst issues – resolved
- Maintenance issues - resolved



The Methane Pyrolysis Reaction



Value Proposition

Clean Hydrogen & Graphite from Natural Gas.

Innovative low emission, low-cost, small footprint, modular technology



Eliminating CCUS, Carbon is an asset

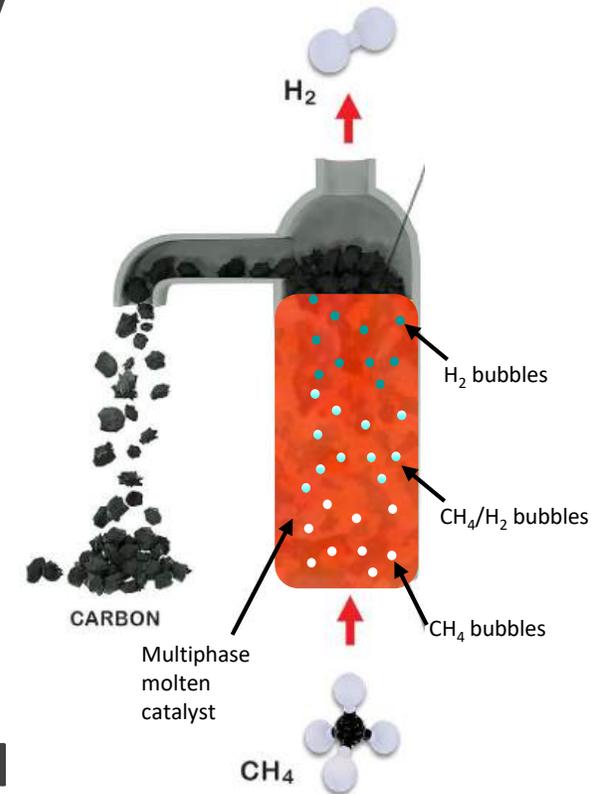
Methane Pyrolysis is splitting natural gas to turquoise hydrogen and graphite (solid carbon)



High throughput and easy separation of solids (Graphite)

Multiphase molten metal reactor combines the advantages of both solid and liquid phase catalysts:

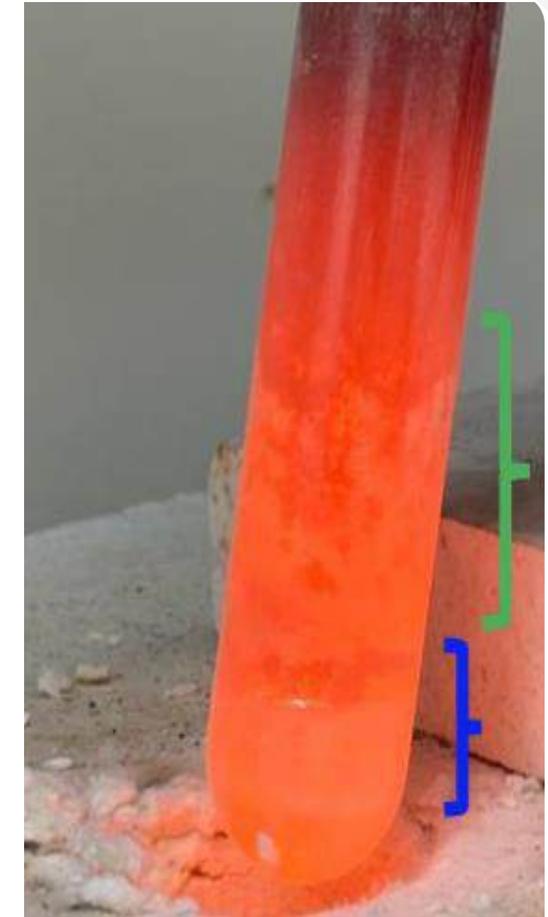
- High reaction rates
- Cycling solid/liquid phases removes suspended solids (coking) and regenerates the catalyst



PyroH2 Multiphase Molten Metal Catalyst

Advantages of **solid and liquid phase catalysts combined**. Traditional generic problems eliminated!

- “Solid like” **High reaction** rates with “Liquid like” suspended solids evacuation (**no coking**)
- Uninterrupted operation to perform **catalyst regeneration**
- Lower Temperature** requirements hence **less energy** and cheaper construction materials
- Longer equipment lifespan** compared with high temperature methane pyrolysis (>1200 °C)



Solid + Liquid.

Liquid

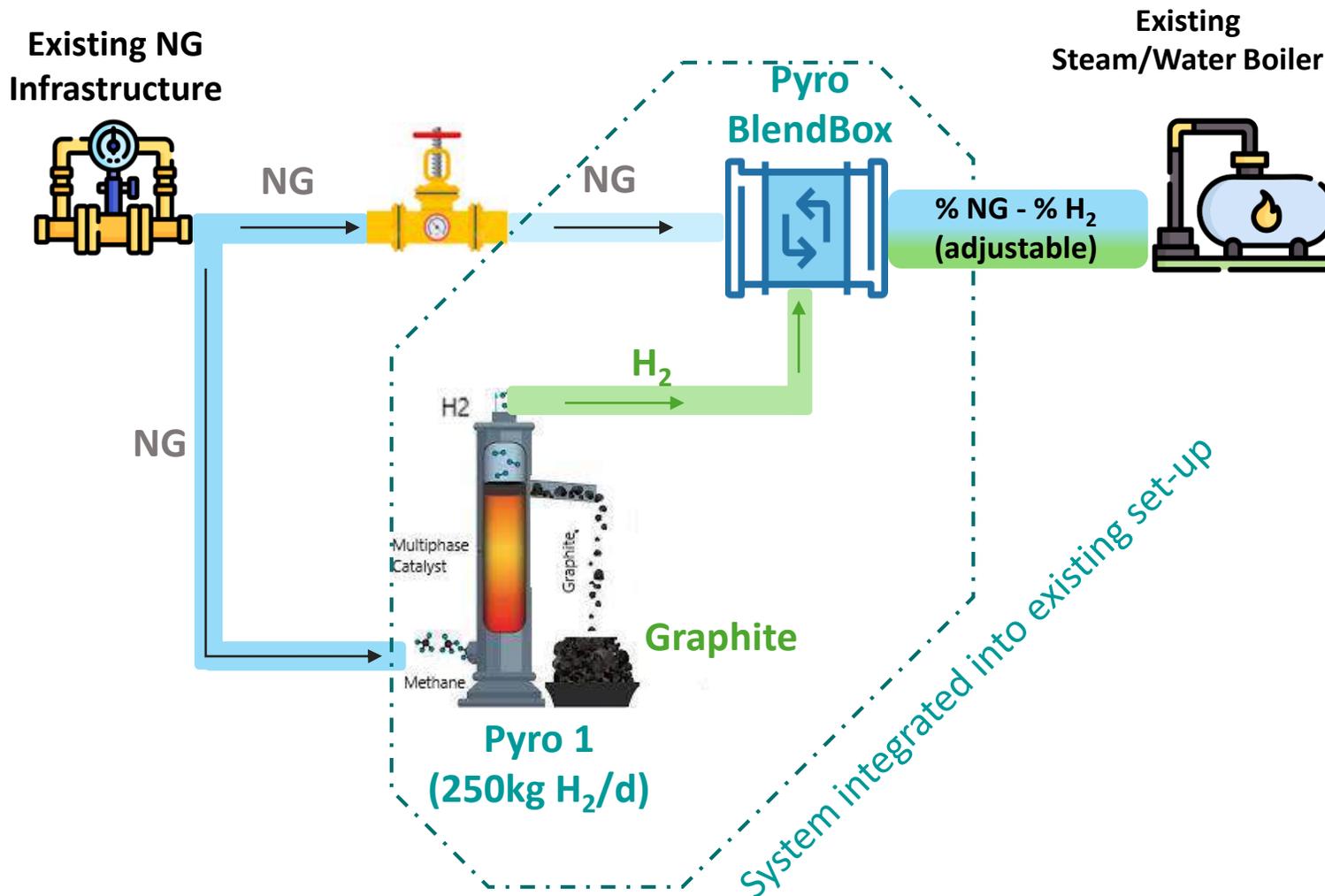
PyroH2 Vertical Column Modular Approach

Highly adaptable to existing infrastructure and site constraints. Significantly reduced O&M Costs.

-  **Small footprint**, add-on to existing infrastructure. H₂ produced adjacent to point of consumption.
-  **Modularity** allows for adaptation to specific requirements of installed units and **gradual decarbonization investments** over time
-  **Full fuel redundancy** and **variable mixes of H₂/NG**
-  **Expandable**. Modules can be added to satisfy growing demand for H₂.



Low Capex & Economically Feasible Phased Decarbonization



- Full fuel supply **redundancy and security**
- On-line conversion of Methane to H₂ seamlessly **integrated into existing infrastructure**
- Mix proportions **controlled and adjustable**
- 1- 4 **Pyro 1** units (250 kg H₂ /day) in a system/cluster
- Unit may be stopped for **O&M** without stopping the entire system/cluster

PyroH2 - Gen 0 (It's working.....!!!)

Compact vertical system



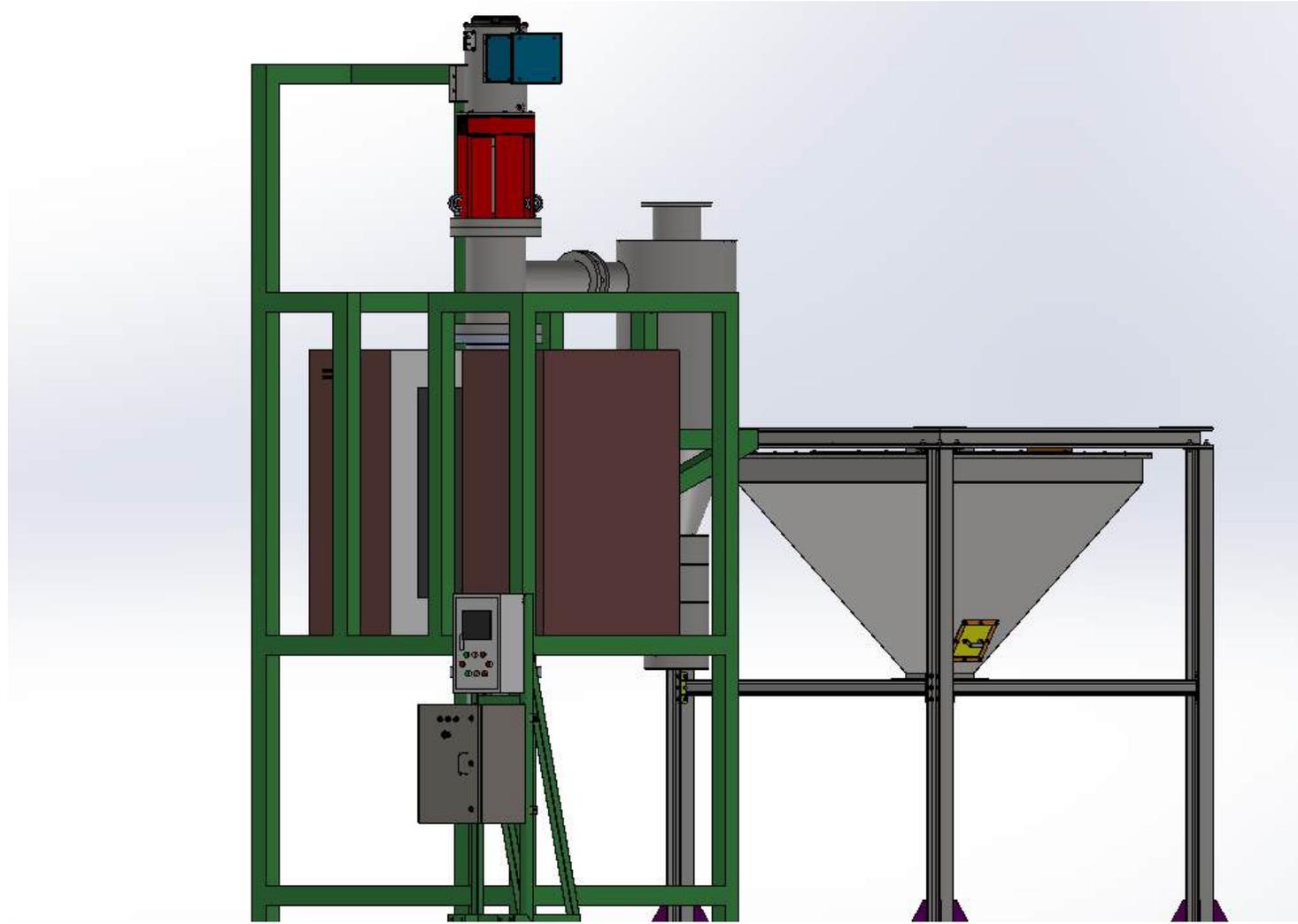
Stainless steel reactor



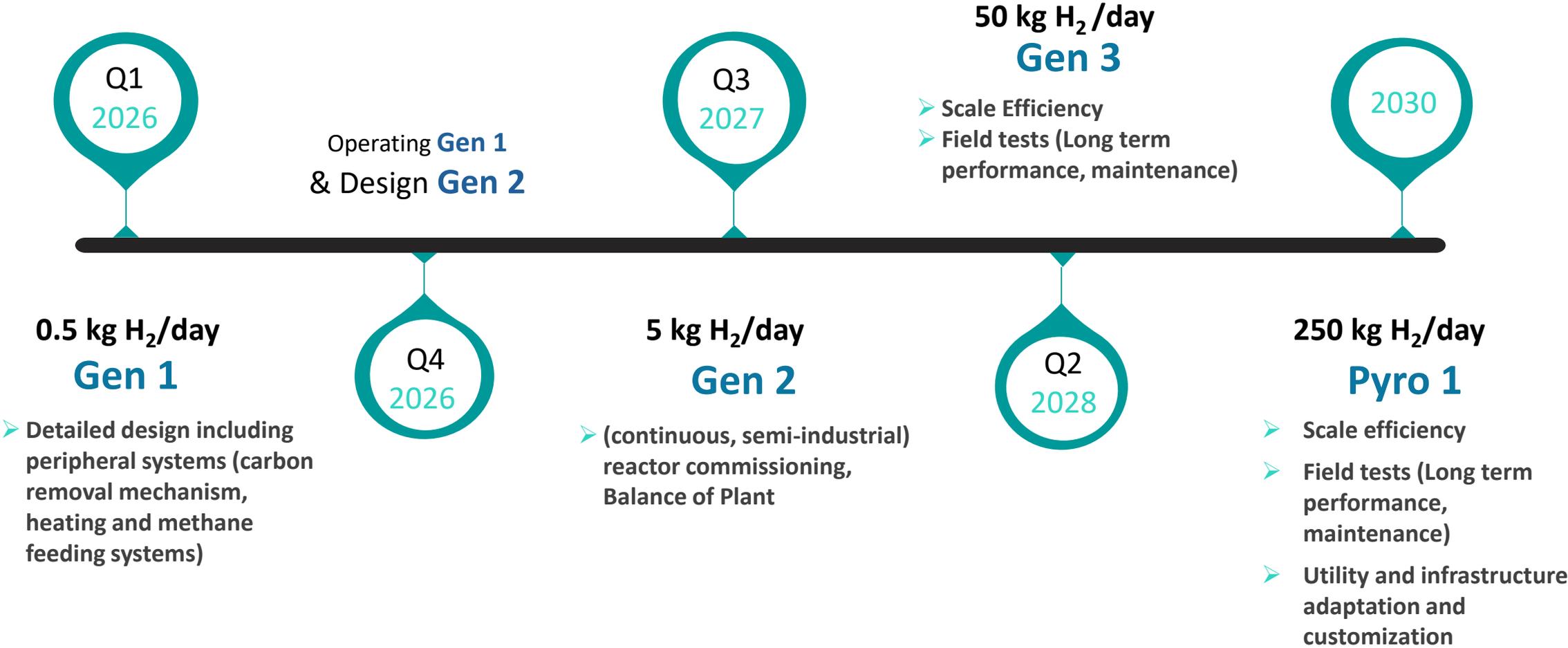
Synthetic Graphite



PyroH2 - Gen 1 (Conceptual design in progress)



Technology Roadmap





PYROH2
LOW CARBON HYDROGEN

Thank You!

