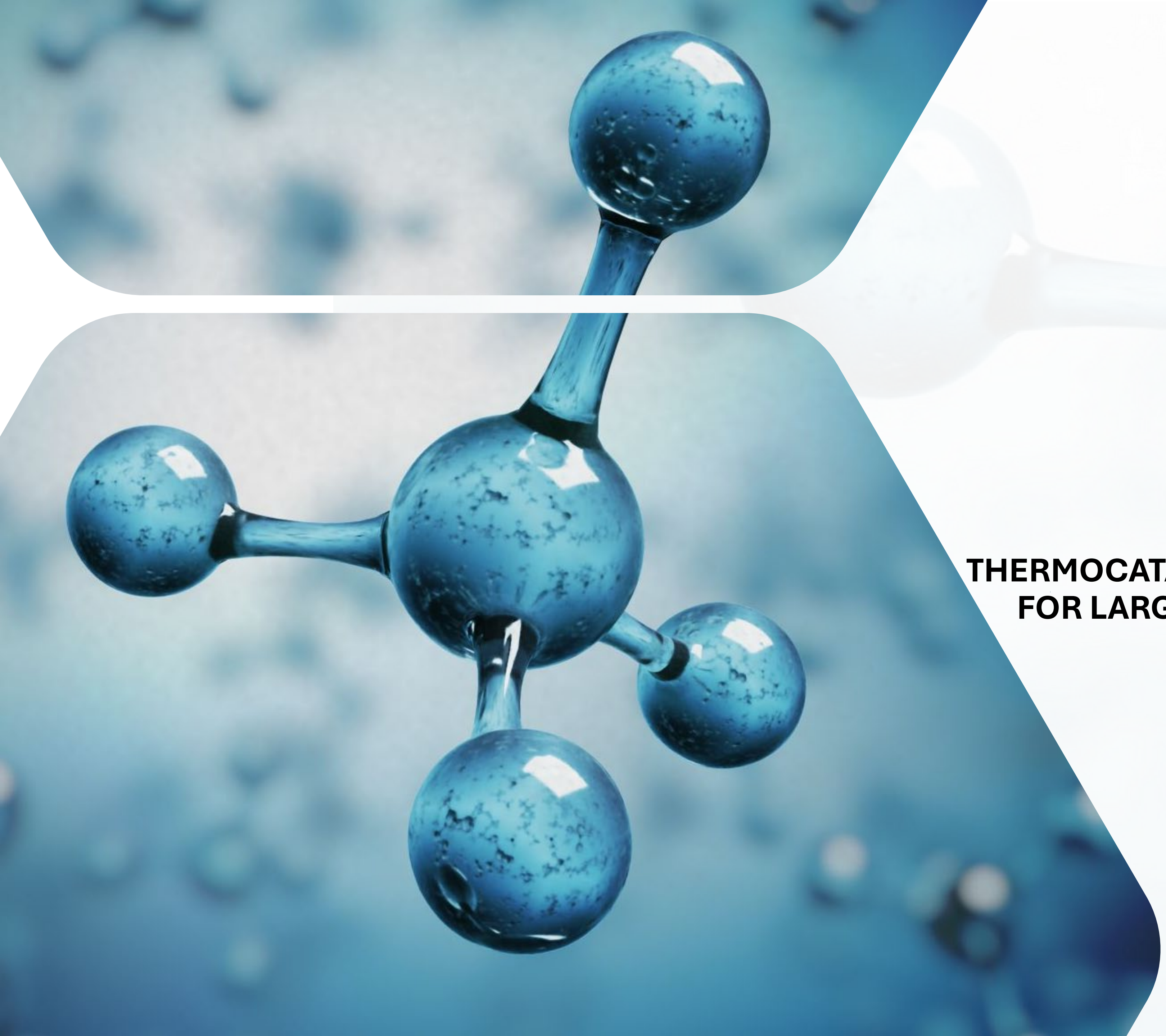

Fulfilling the Hydrogen Demand:

LEVERAGING THERMOCATALYTIC METHANE DECOMPOSITION FOR LARGE-SCALE HYDROGEN PRODUCTION

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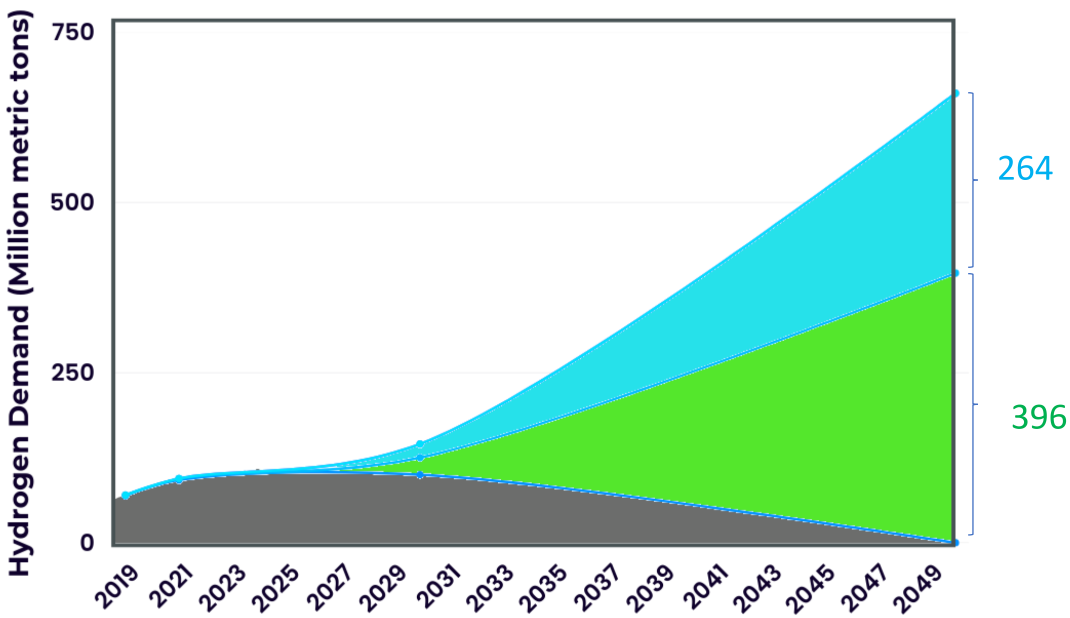
H_2 2023 Vs 2050

- Current Global demand for Hydrogen: ~94.3 million metric tons p.a. (2021) and will be doubled by 2030[a].
- Demand by 2050: 660 million metric tons p.a.

	2021	2050
Steam Methane Reforming (SMR)[b]	:76%	~0%
Coal Gasification (CG)[b]	:22%	~0%
Electrolysis[b]	:2%	60%
Alternative methods	:<1%	40%

Type of hydrogen	LCOH* (USD /kg of H_2)	Energy requirement (kWh /kg of H_2	C-intensity (kg/kg of H_2)
Grey (SMR*)	1.35	0.31	9.26
Blue (SMR+CCS*)	2.01	1.11	1.03
Green	9.49	54.2	<1 (if renewable energy is used)
Turquoise (By methane cracking)	1.87	11	<1 (if renewable energy is used)
Bio Hydrogen (AD*+Turquoise)	<1	~11	Negative



a: https://www.statista.com/statistics/1121206/global-hydrogen-demand/

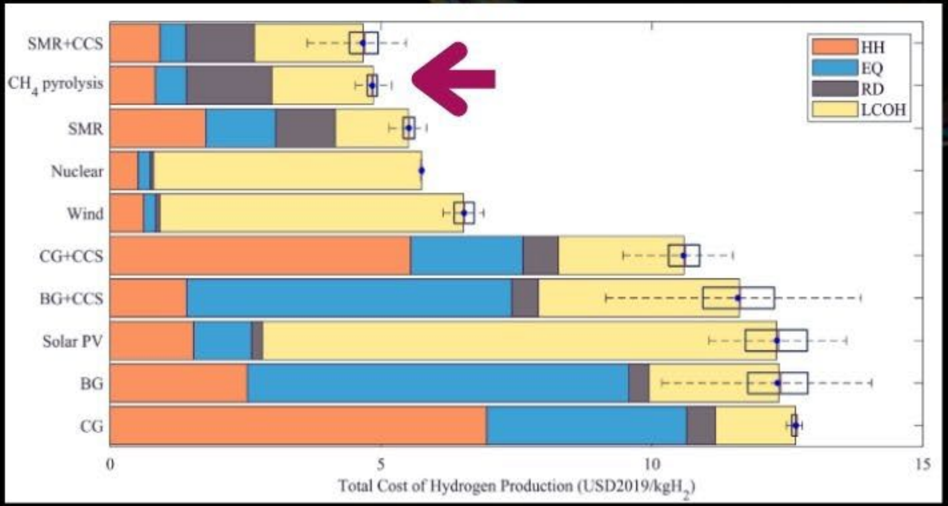
b: https://www.energypolicy.columbia.edu/publications/hydrogen-fact-sheet-production-of-low-carbon-hydrogen/

THE POWER OF THERMOCATALYTIC METHANE CRACKING

$$CH_4 \xrightarrow[\text{74.8 kJ/mol}]{\text{Catalyst}} C + 2H_2$$

(74.8 kJ/mol[1])

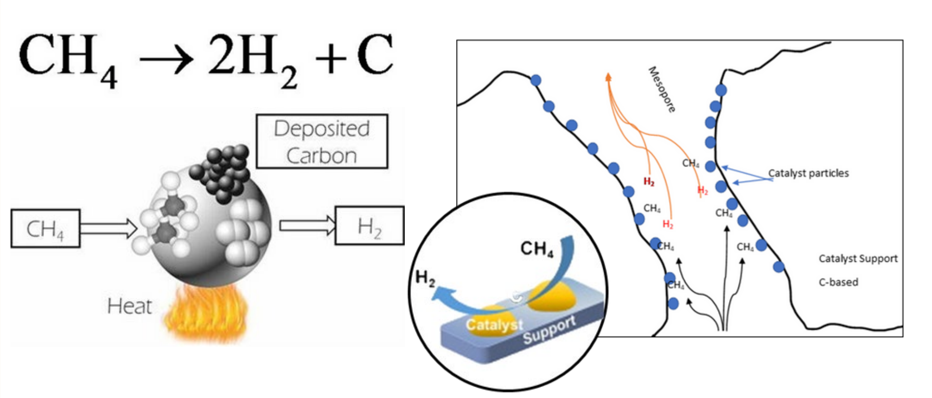
- Potential solution for hydrogen storage
- Produces solid carbon as a by product
- High conversion yield (>95%)
- Scalability
- Adaptability to fluctuating energy demands
- Potential to integrate with renewable/carbon negative feedstock/energy sources (i.e. Bio methane)



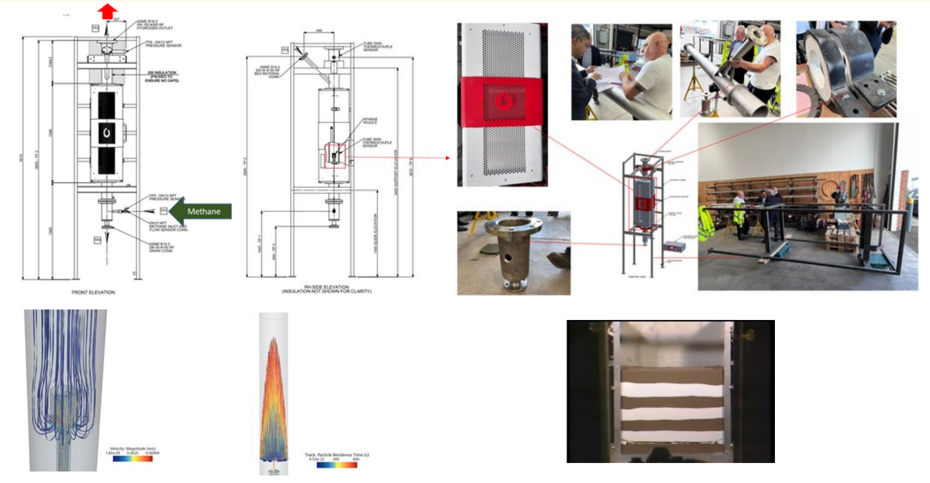
1. https://doi.org/10.1016/j.ijhydene.2023.12.042
2. https://doi.org/10.1016/j.apenergy.2020.115958

RESEARCH AREAS

REACTION OPTIMISATION



REACTOR DEVELOPMENT/SCALE-UP



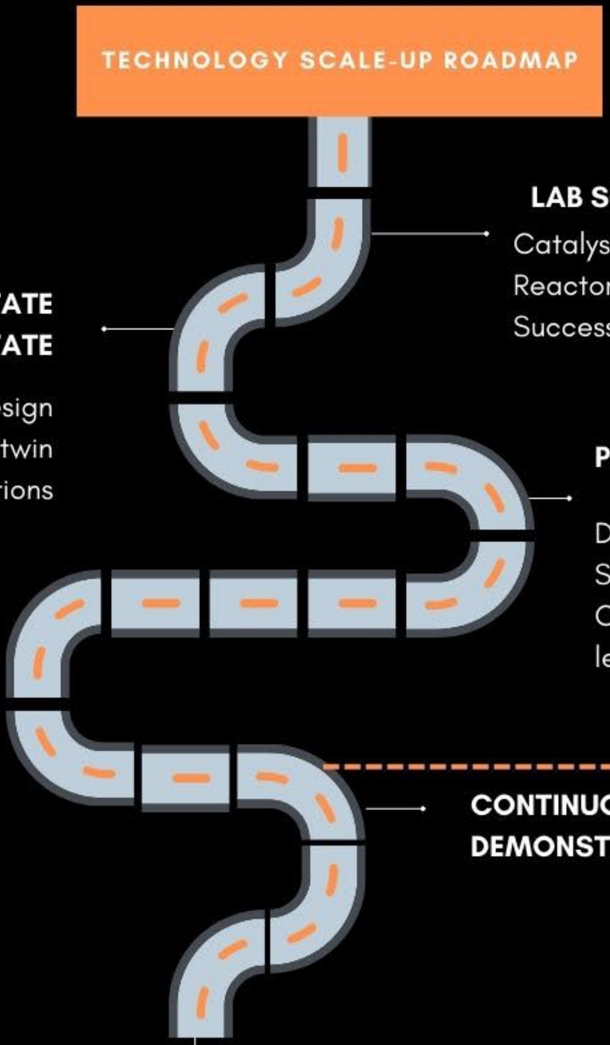
VALUE ADDITION TO CARBON

- NEXT GENERATION THERMAL MATERIALS
- CATALYSIS
- NEXT GENERATION HIGH INTEGRITY MATERIALS
- NEXT GENERATION FERTILISER
- NEXT GENERATION SUPERCAPACITORS

CARBON BUDGETING

CARBON FOOTPRINT
LIFE CYCLE ANALYSIS
TECHNOECONOMIC ANALYSES

TECHNOLOGY UPSCALING: THERMOCATALYTIC METHANE CRACKING



LAB SCALE PROCESS DEMONSTRATION

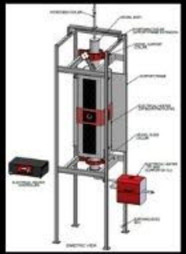
Catalyst formulation
Reactor Modification
Successful production ~80% conversion yield of H2

CONVERSION OF THE PROCESS INTO A CONTINUOUS STATE FROM BATCH STATE

Reactor re-design
Carbon dislodging characteristics via digital twin
Functional Verifications

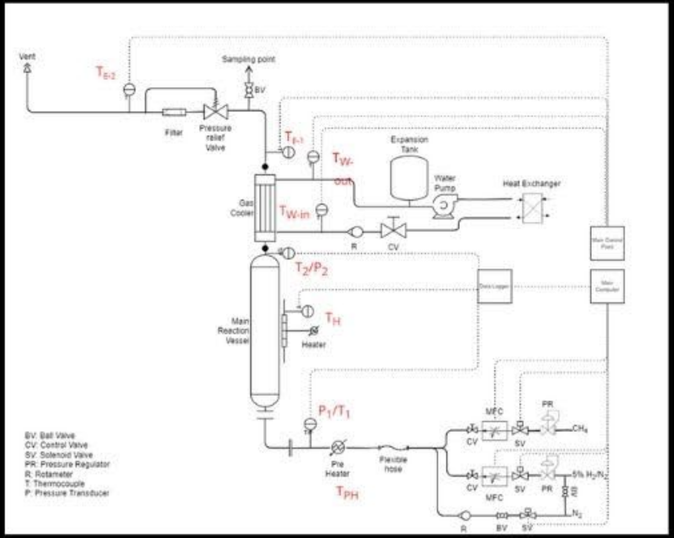
PILOT SCALE DEMONSTRATION

Developing a pilot scale facility
Successful 24 hr demonstration
Converting to a continuous process from the learnings taken from the previous reactors.



2024

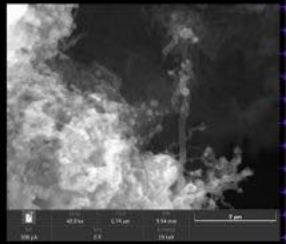
CONTINUOUS PILOT SCALE DEMONSTRATION

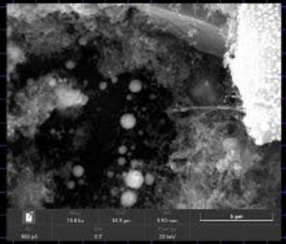


PILOT FACILITY P&ID

GOAL

COMMERCIAL H2 PRODUCTION





BY PRODUCT CARBON MATERIALS

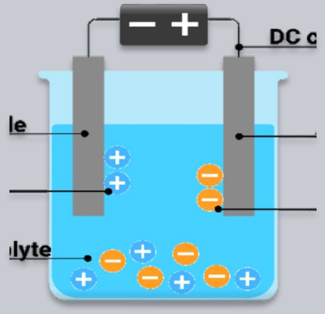
How does each method affect the cost?

(Levelised costs of H_2 from 2016-2019, basis as close as possible, adding CCS lowers TRL slightly)

Steam Methane Reforming (SMR)

+ CCS

TRL = 9
LCOH ≈
£2.40 /kg

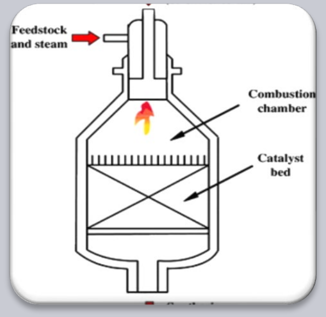


Electrolysis – Wind, solar, nuclear

TRL = 9

LCOH ≈

£4.5-9 /kg

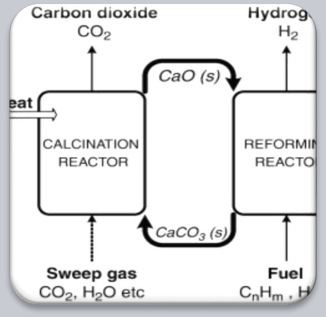


Autothermal reforming (ATR) + GHR + CCS

TRL = 9

LCOH ≈

£2.70 /kg

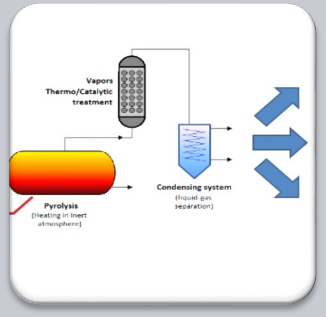


Sorption Enhanced Steam Methane Reforming (SE-SMR)

TRL = 6

LCOH ≈

£1.90 /kg



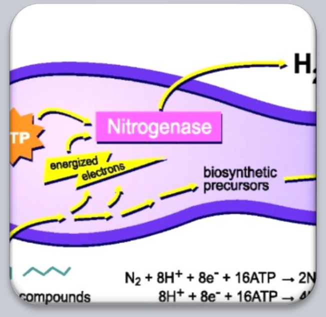
Coal / biomass Gasification or methane pyrolysis

+ CCS

TRL = 8

LCOH ≈

£2.50 /kg

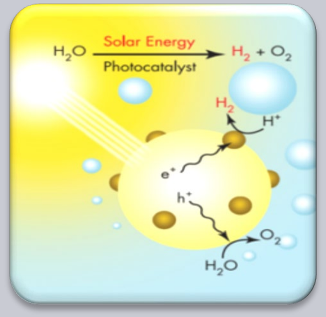


Biological methods

TRL = 3

LCOH >

£11 /kg



Water splitting – Photon based

TRL = 3

LCOH ≈ £1.50 /kg

Cranfield HyPER project and https://pubs.rsc.org/en/content/articlelanding/2019/ee/c8ee02079e#!divAbstract
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/760479/H2_supply_chain_evidence_-_publication_version.pdf

1 response submitted

Which of the following do you believe will be the most significant factors in-fluencing the development and adoption of hydrogen energy between 20...

Technological advancements	0%
Policy and regulatory changes	50%
Economic factors	50%
Public perception and acceptance	0%
Infrastructure development	0%

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