Gas **S**witching **R**eforming for Clean Hydrogen Production with CO_2 Capture (**GSR**)

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Overview

- Technology characteristics
- Technology advantages
- Planned project approach

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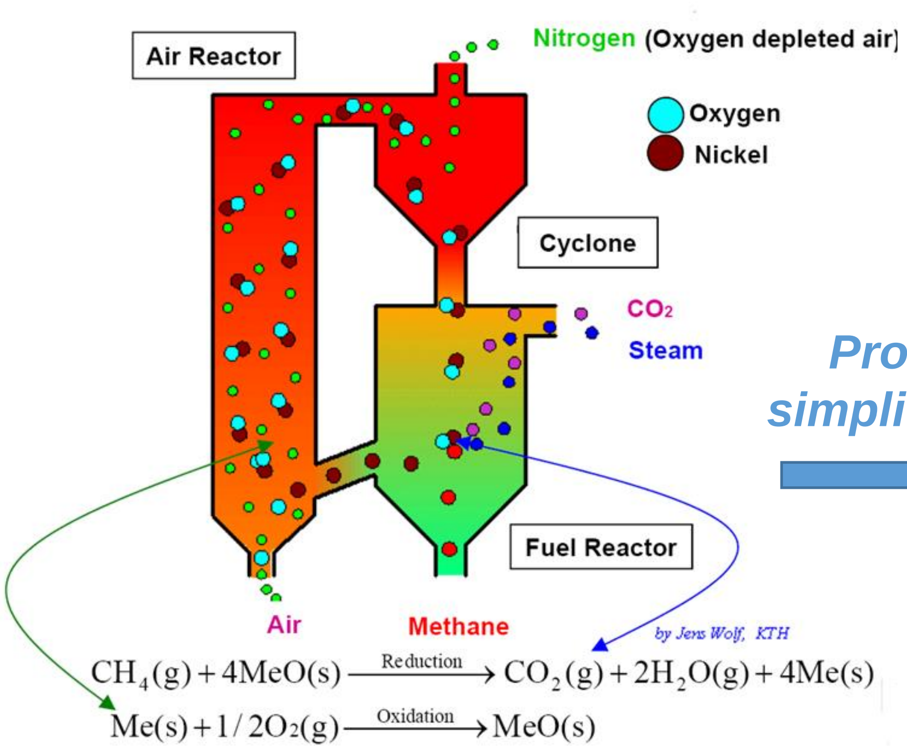
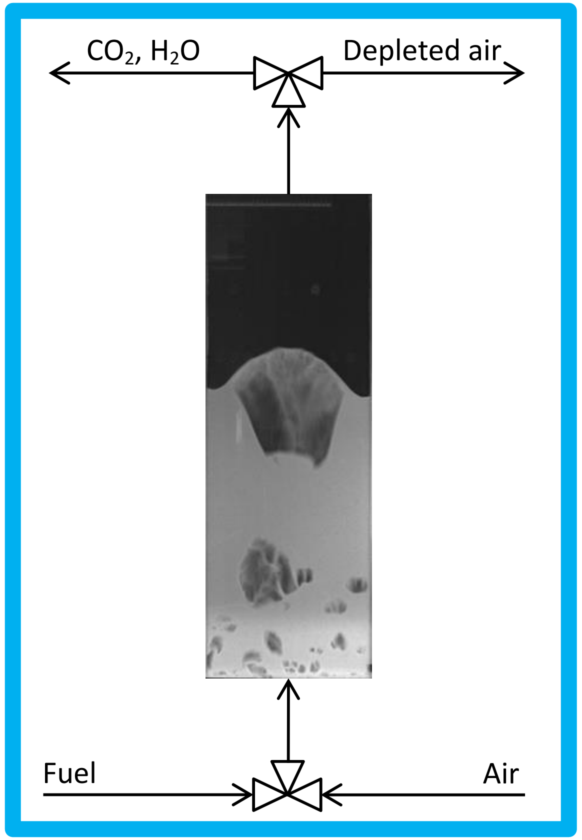
Gas Switching Reforming (GSR) based on the Chemical looping



- **Air reactor: Reduced metal (Me) is oxidized by air, producing a high temperature N_2 stream**
- **Fuel reactor: Metal oxide (MeO) provides oxygen for combustion to produce only CO_2 and steam**

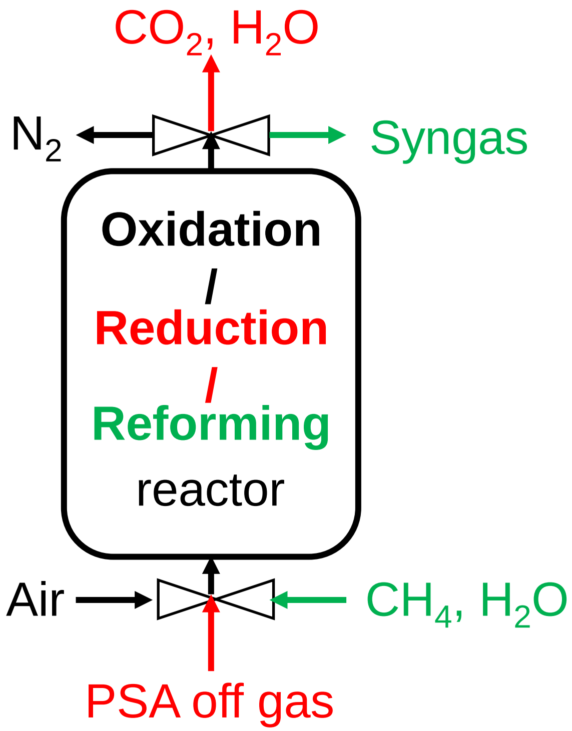
Process simplification

Gas Switching Technology



- **Single fluidized bed configuration**
- **No external solids circulation**
- **Easy to pressurize and scale up**
- **High load flexibility**

Gas Switching Reforming (GSR)



Tested previously at TRL3
*(Ugwu,..., **Amini**, et al., Int. J. GHG Control, 114 (2022) 103593)*

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Advantages of H_2 production via GSR relative to conventional steam-methane reforming in packed bed

Consideration	Packed Bed Reactor	GSR	Advantage
Efficiency of CO_2 capture	Requires expensive and inefficient post-combustion CO_2 capture	Inherent CO_2 capture with no direct energy penalty	Gas switching mechanism avoids contact between N_2 and CO_2
Efficiency of heat transfer	Substantial heat transfer limitations to the reforming tubes and inside the packed catalyst bed	Heat from combustion reactions is stored directly in the thermal mass of the catalyst for use during reforming	Perfect heat transfer from combustion to reforming leads to high reforming temperatures and fuel conversion
Required air flowrate and resultant N_2 purity	Excess air must be fed to achieve complete fuel combustion	Air can be fed in a stoichiometric ratio due to the high reactivity and reduced state of the oxygen carrier	Smaller required air feed rate produces a high purity N_2 stream and extracts less heat from the process

Experience in building pilot plants for Chemical Switching Technology

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Project Approach

We aims to move GSR from TRL 3, based on our previous experimental and TEA studies, to TRL 4, via completing the following tasks:

1. Conceptual design of a decarbonized large scale industrial GSR operating at elevated pressure using non-nickel-based oxygen carriers
2. Limited experimental kinetic measurements over non-nickel based oxygen carriers
3. Preliminary techno-economic analysis (TEA)
4. Preliminary life cycle analysis (LCA)
   - TEA and LCA to build upon our previously published TEA (Nazir, ..., **Amini**, et al., *Int. J. Hydrogen Energ.*, 46 (2021) 20142-20158
5. Development of technology maturation plan (TMP), environmental health and safety (EH&S) analysis, and technology gap analysis
6. Business case development

Budget: $250k

Duration: August 1, 2024 – July 30, 2025

Thank you!

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