







#### Headline results



- Overall objective:
  - Productivity (kg CO<sub>2</sub>/m<sup>3</sup>hr) increase
    by a factor 10 of sorbent based
    capture technologies
- Means:
  - Additive manufacturing,3D-printing
- Materials:
  - Hydrotalcite
  - Amine Functionalised Silica

ecn.nl Three Dimensional Printed Capture Materials for Productivity Step-Change 3

# COST REDUCTION BY INCREASED PRODUCTIVITY

NAME AND INCOME.



#### More compact operation

• Structured sorbents vs. conventional technologies



**Full Train PSA** 



Full Train PSA







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## Key activities

- Design tailored structures by CFD modelling
- Develop appropriate manufacturing procedures
- Test the performance under relevant conditions
- Assess the economic advantages





#### Advantages of Structured Beds



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## Two application areas

- SEWGS Challenge: WGS Conversion at very high throughputs Medium temperature (300-500°C) Reactive pressure swing adsorption technology using hydrotalcites; syngas processing with CO<sub>2</sub> capture; decarbonised H<sub>2</sub> production for refineries together with natural gas combined cycle
- ImmoAmmo Challenge: Heat management at very high throughputs Low temperature (40-130°C)
   Vacuum pressure / temperature swing adsorption Amine-functionalized silicas; replacement of solvent-based systems for CO<sub>2</sub> removal. Natural gas combined cycle post-combustion configuration.



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## Applications in 3D-CAPS



Typical capture options in H<sub>2</sub> production



#### Additive Manufacturing of Porous Materials



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#### **3D-CAPS** consortium





## Roles

	ECN	Coordination. Development of Paste and 3D-Printing. Modelling of SEWGS systems. Experimental testing for SEWGS sorbent at TRL4/5					
	3D-CAT	Business plan development, risk management of the project. Techno- economic analysis and business plan development.					
	BP	Support techno-economic analysis and preparation for TRL6 demonstration. Representative of Carbon Capture Project					
	SINTEF	Testing for ImmoAmmo at TRL4/5. Modelling Silica-based materials. Alternative route of Silica functionalisation					
	AKSO	Techno-economic analysis of ImmoAmmo implementation and development of business plan for spin-off application areas					
	UBB	CFD optimum structure determination and cyclic modelling of SEWGS and ImmoAmmo systems					
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## Budget

	2017	2018	2019	total
Personnel	432	727	670	1830
Operating	57	37	17	112
Equipment	11	12	10	33
Other	72	23	23	118
	571	800	721	2093

Delayed start of the project will lead to an underspending in 2017



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# Application 1: SEWGS

- Water gas shift reaction at 400°C is thermodynamically limited
- Combines the Water-Gas-Shift reaction with sorbent material to simultaneously produce H<sub>2</sub> at high temperature whilst also capturing CO<sub>2</sub>

$$CO + H_2O \leftrightarrow CO_2 + H_2 \qquad \Delta H = -41 \text{ kJ/mol}$$
  
In situ removal





