Developments in the SEWGS CO_2 capture technology.

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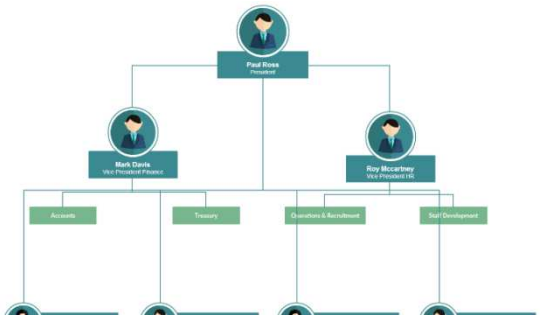
CATO Meets the Projects

Utrecht, 15 November 2017

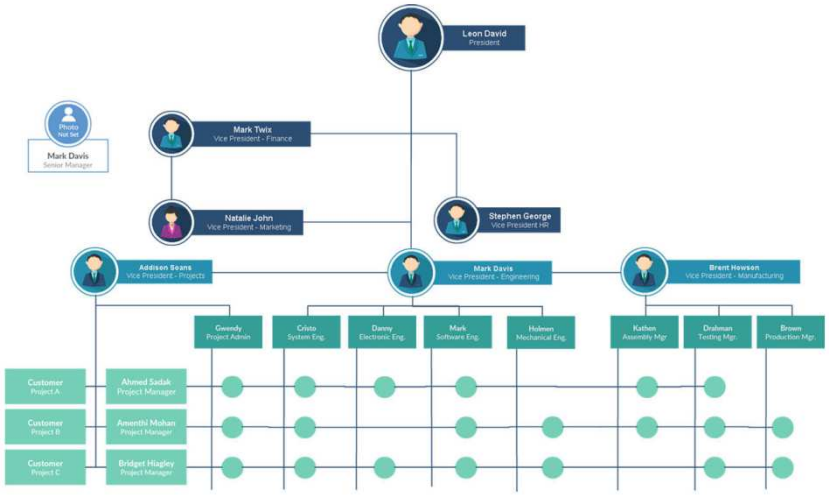
ECN

Organizational structures

Traditional hierarchy



The Matrix



We are financed like a matrix!

International → National

SEWGS suit

STEP WISE

FReSMe

Accelerating CCS Technologies

3D CAPS

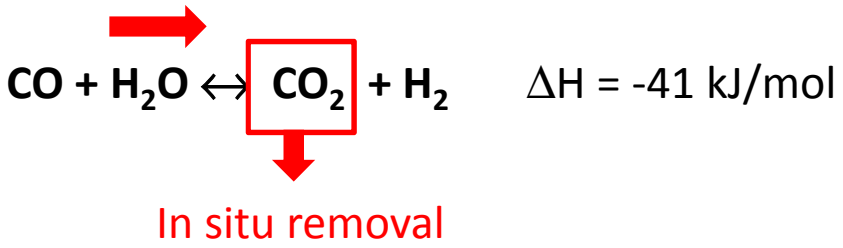
TOPSECTOR ENERGIE
Empowering the new economy

CURE
CO_2 to **Ure**a

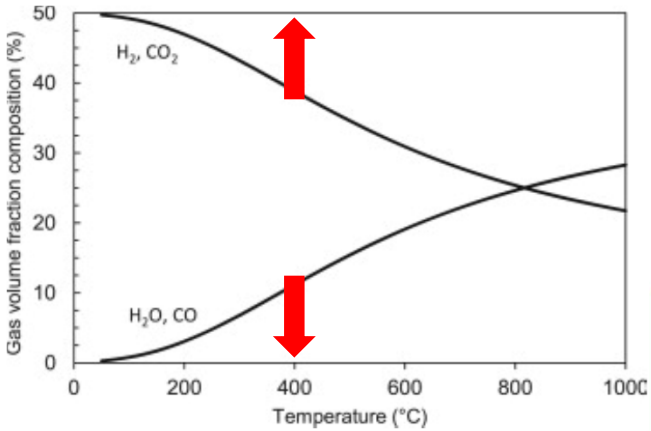
Ministerie van Economische Zaken

Sorption Enhanced Water Gas Shift

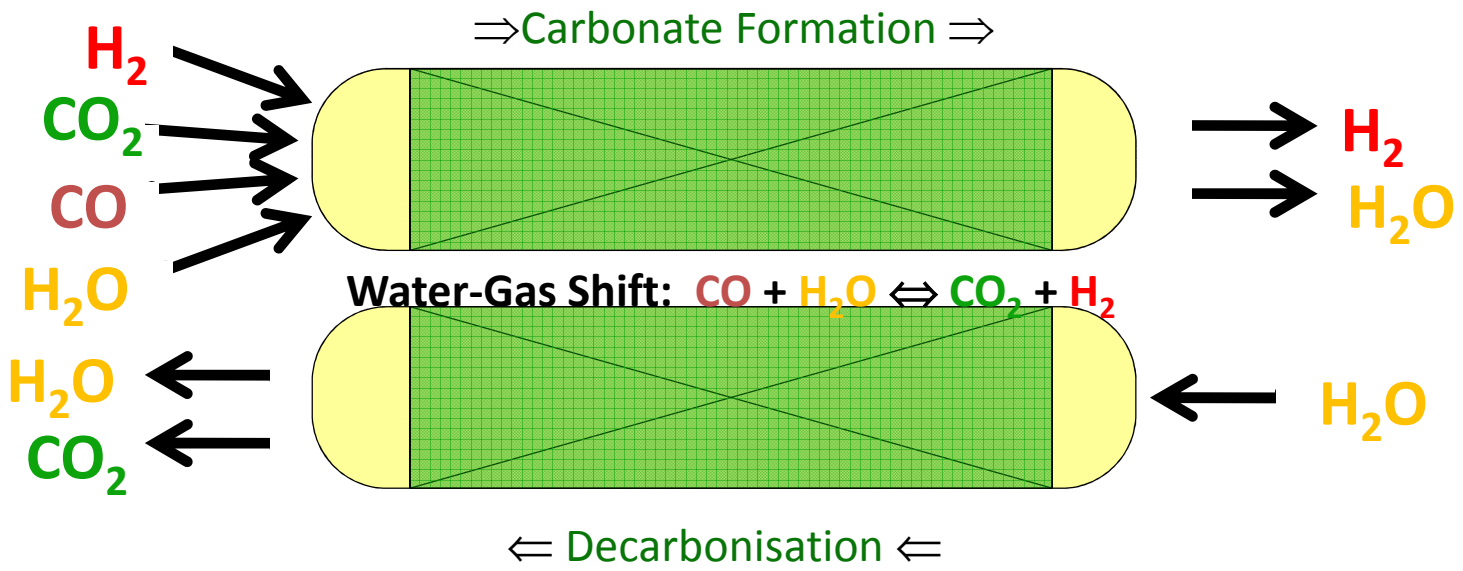
- Water gas shift reaction at 400°C is thermodynamically limited
- Combines the Water-Gas-Shift reaction with sorbent material to simultaneously produce H_2 at high temperature whilst also capturing CO_2



ΔH = -41 kJ/mol



SEWGS in action



SWOT - SEWGS

Strength

- Highly efficient technology
- Very suitable for the steel industry
- Low-cost process and sorbents

Weakness

- Technology only proven in the lab
- Business cases not fully defined
- Technology needs to be more compact

Opportunities

- The Netherlands aims to store 20 MT/y CO_2
- Increased industrial budgets for the reduction of their carbon footprint
- CCUS is essential for deep decarbonisation

Threats

- CCUS suffers from a negative public perception
- For political and geological reasons, CO_2 storage is not possible in all countries
- World wide climate leadership is weak

Very suitable for the steel industry

RESIDUAL STEEL GASES

Residual streams contain energy

- Unique feature of current steel making processes
- Presence of diluted energy containing streams

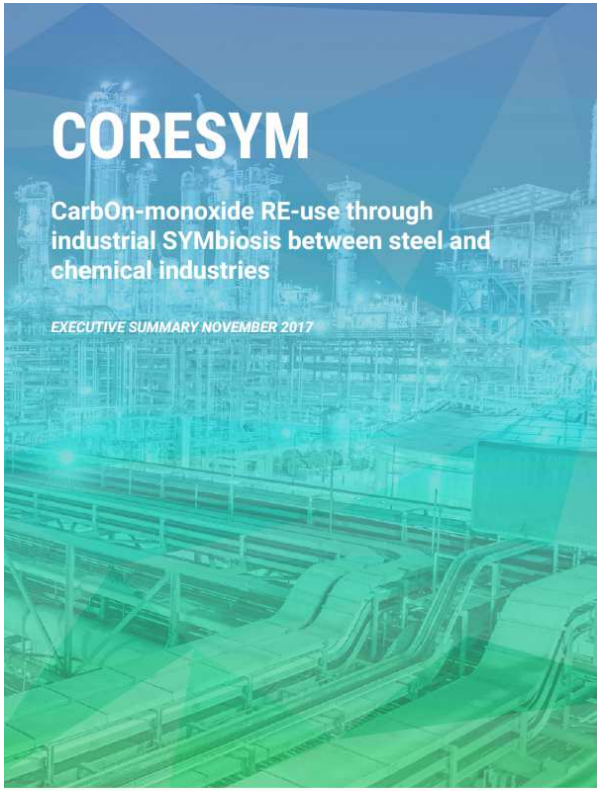
Gas type	CO_2	CO	N_2	H_2	CH_4	LHV (MJ/Nm^3)
BOF gas	19	58	20	3	--	8
BF gas	24	23	49	4	--	3.5
CO gas	2	5	7	62	24	18

See IEAGHG report on Iron&Steel,
http://www.ieaghg.org/docs/General_Docs/Reports/2013-04.pdf

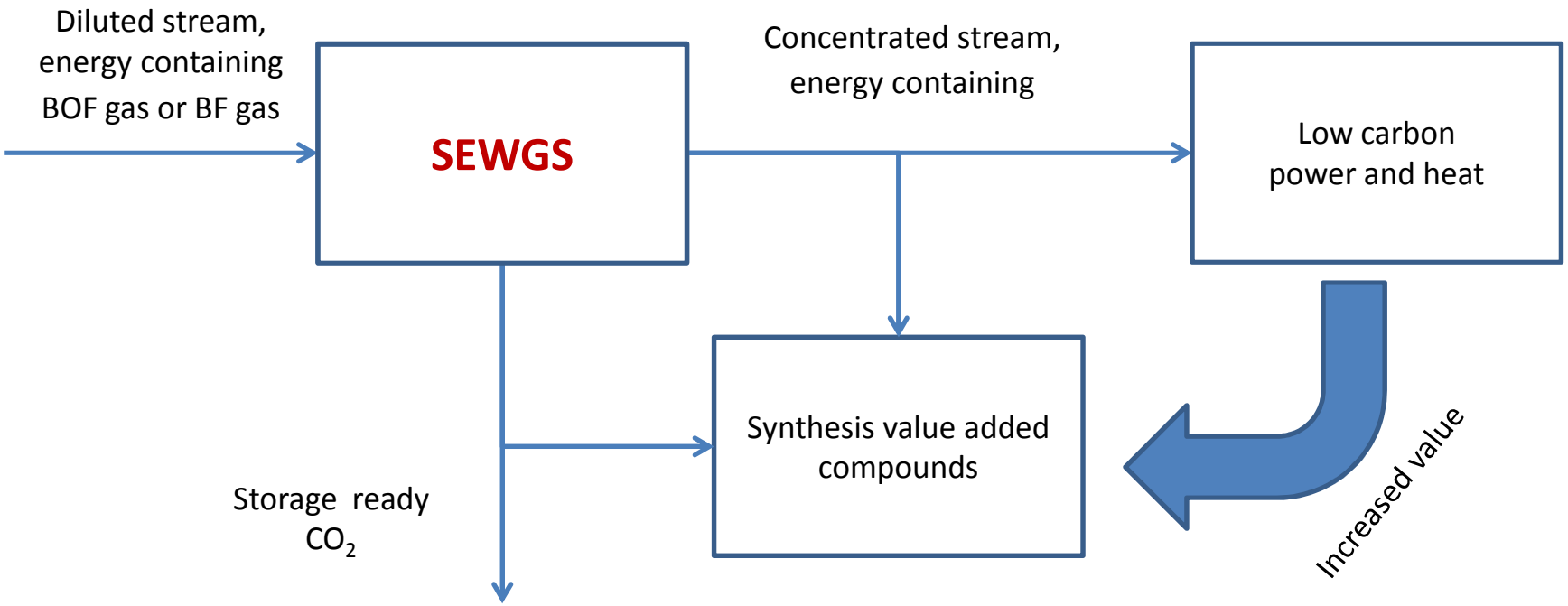
BOF gas – Basic Oxygen Furnace gas, BF gas – Blast Furnace gas
CO gas – Cokes Oven gas

External validation

be profitable. On the longer term, the very promising SEWGS route will become available on a commercial scale. Currently this route is at a Technology Readiness Level (TRL) or around 6 or 7. The SEWGS route is shown to be profitable, with a payback period of 8 years for the production of methanol and 2 years for the production of hydrogen using this route. However, one downside of

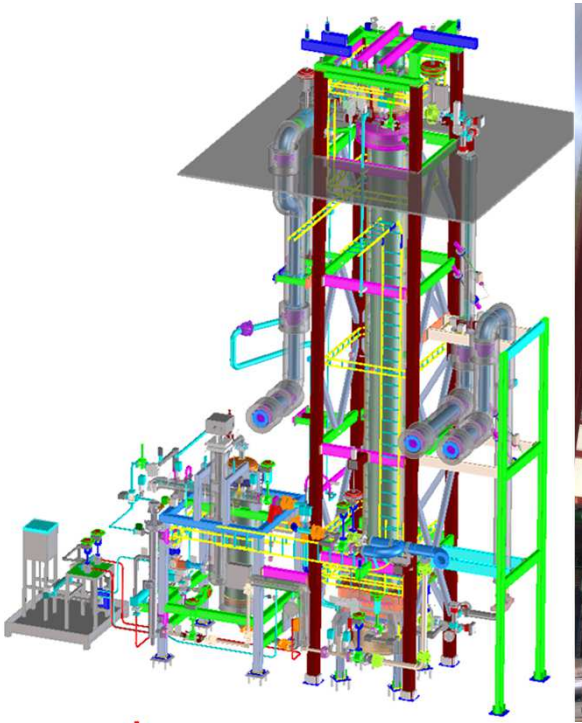


Approach


Diluted stream, energy containing BOF gas or BF gas
SEWGS
Concentrated stream, energy containing
Low carbon power and heat
Synthesis value added compounds
Storage ready CO_2
Increased value


Technology only proven in the lab
PILOTING IN THE STEEL INDUSTRY

Progress



From design to construction and official opening September 2017

STEPWISE: the movie

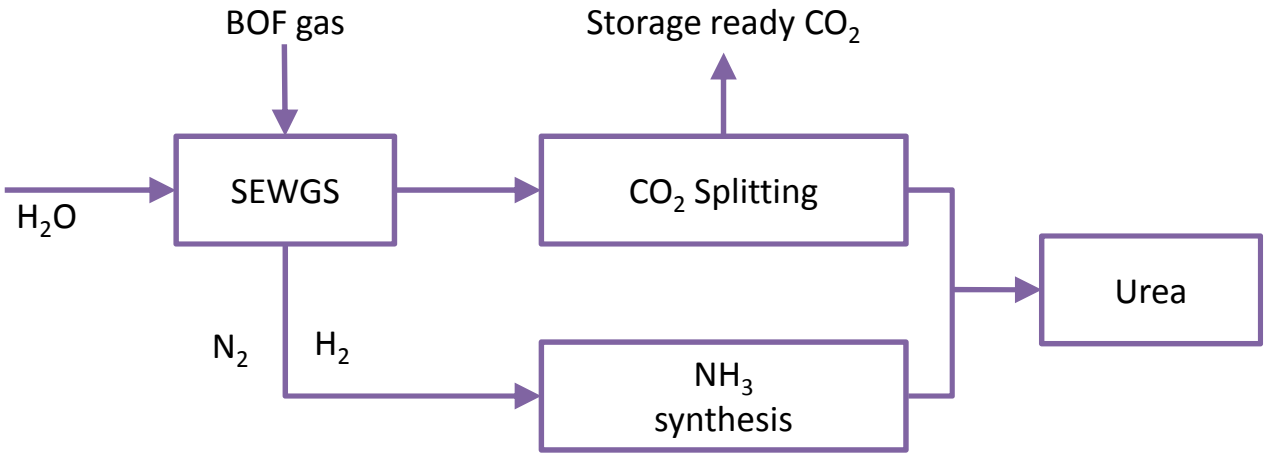
https://www.youtube.com/watch?v=A-EpcBt9uN4

Business cases not fully defined

FERTILIZERS FROM RESIDUAL STEEL GASES

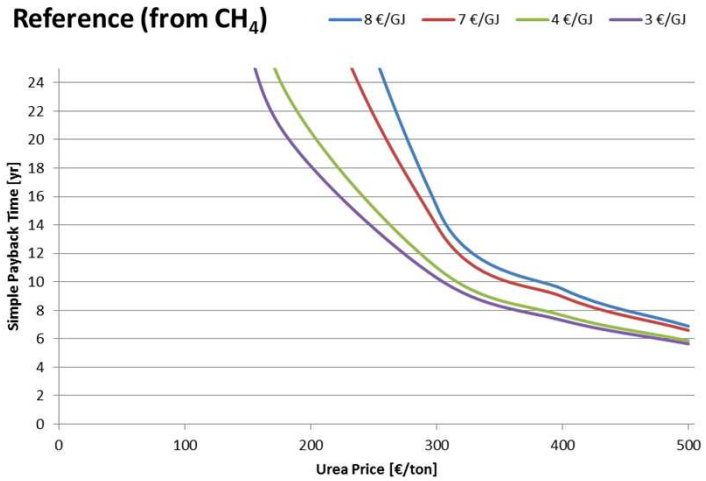
Production of value added chemicals

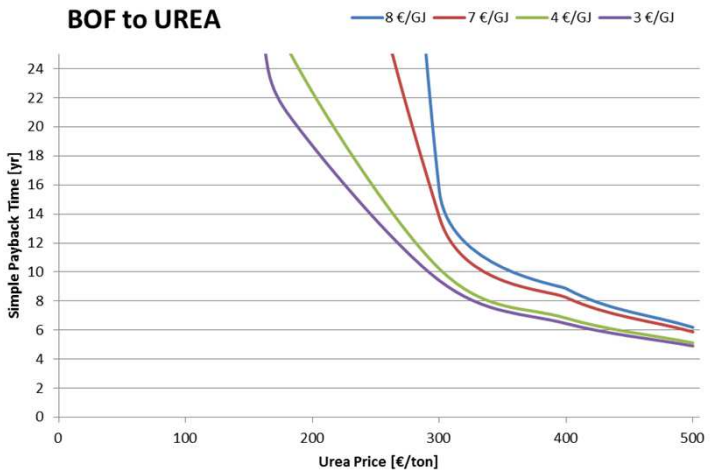
- Residual gases in the steel industry contain N_2
- After SEWGS,
  - the N_2 goes with the H_2,
  - need for removal before hydrocarbon synthesis
- Treated BOF gas has the right H_2/N_2 ratio for ammonia synthesis



Business Case

- Comparable economics natural gas based and BOF-gas based urea
- Urea pays for capture technology: storage ready CO_2 for free



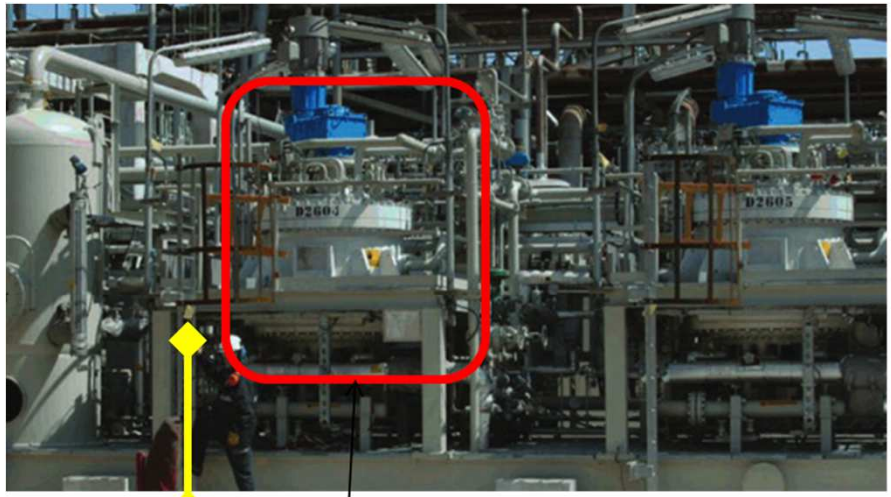


Technology needs to be more compact

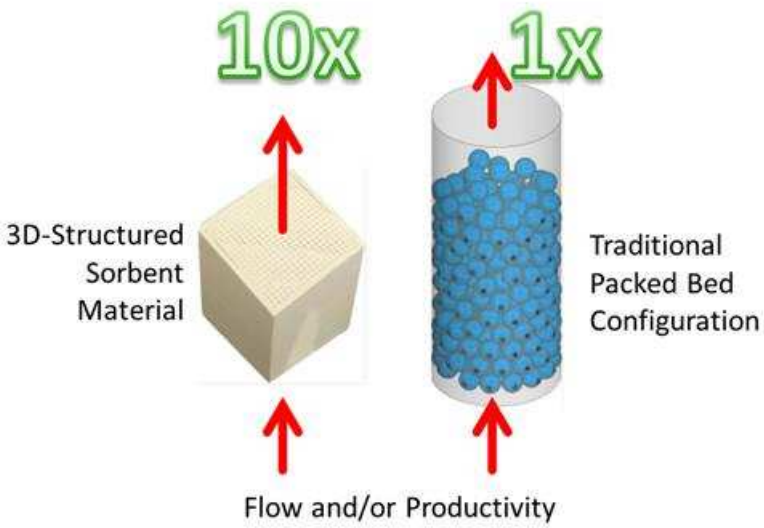
COST REDUCTION BY INCREASED PRODUCTIVITY

More compact operation

- Structured sorbents vs. conventional technologies

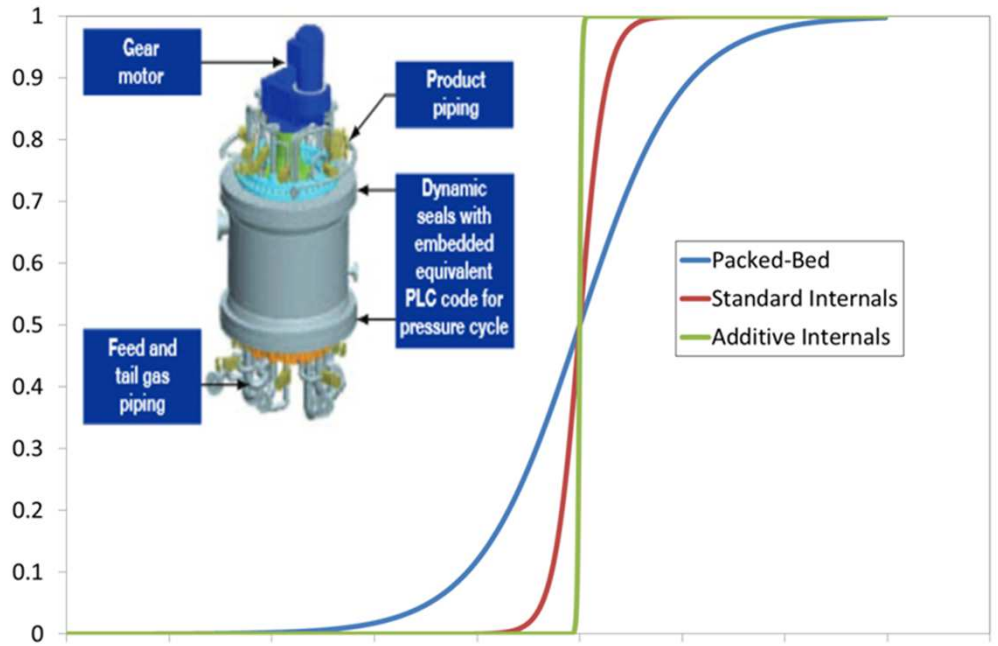


3-Dimensional structure sorbents

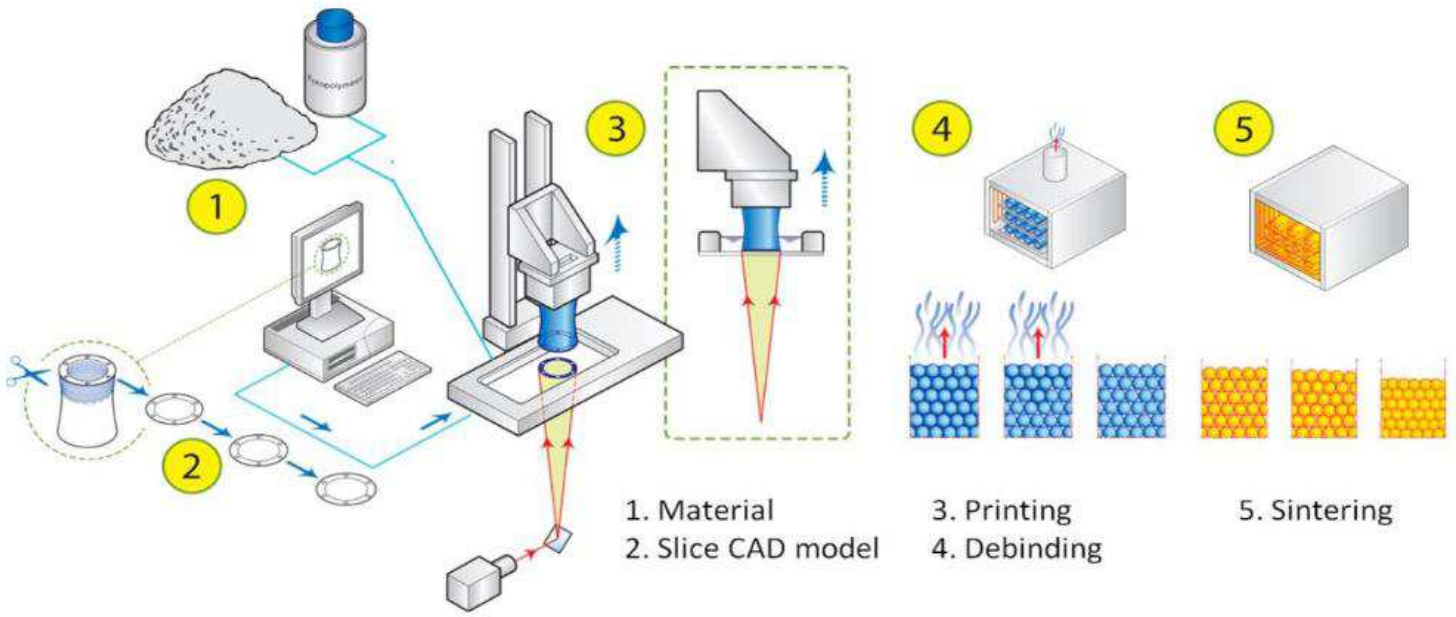


- Overall objective:
  - Productivity [kg CO_2/(m^3hr)] increase by a factor 10 of sorbent based capture technologies
- Means:
  - Additive manufacturing, 3D-printing
- Materials:
  - Hydrotalcite
  - *Amine Functionalised Silica*

Advantages of structured beds



Additive manufacturing of porous materials



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CURE

CO_2 to **Ure**a