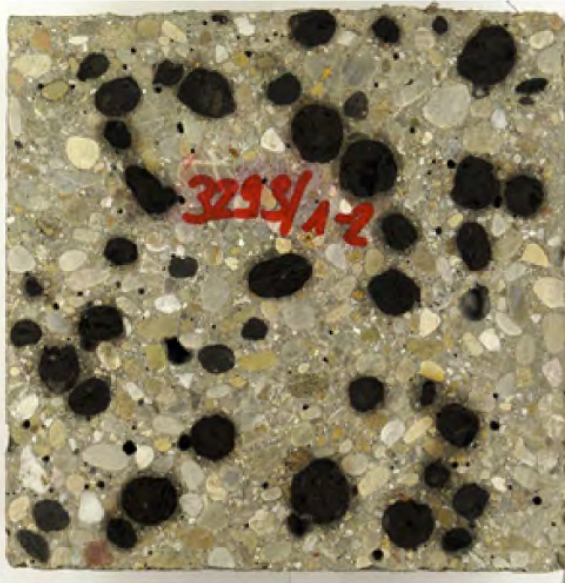




swiss center of excellence
on net zero emissions

SCENE



ETH Joint Initiative SCENE Swiss Center of Excellence on Net-Zero Emissions

Action area: Technical CCUS

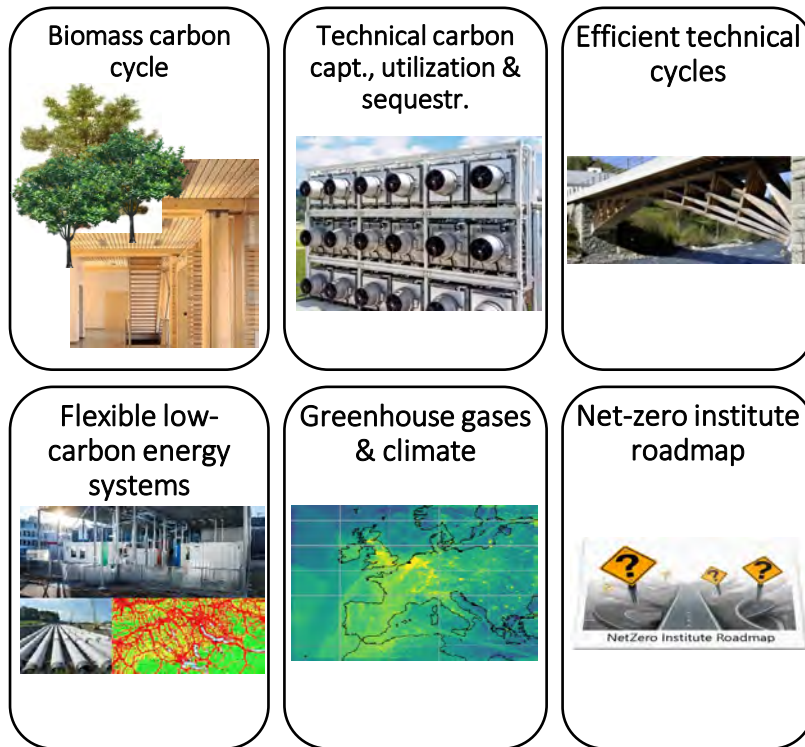
Wim Malfait

Laboratory for Building Energy Materials and Components, Empa

CCUS Stakeholder Dialogue, EPFL Sion, 15 June 2026

NetZero Priority Action Areas

Portfolio analysis from
>200 NetZero activities

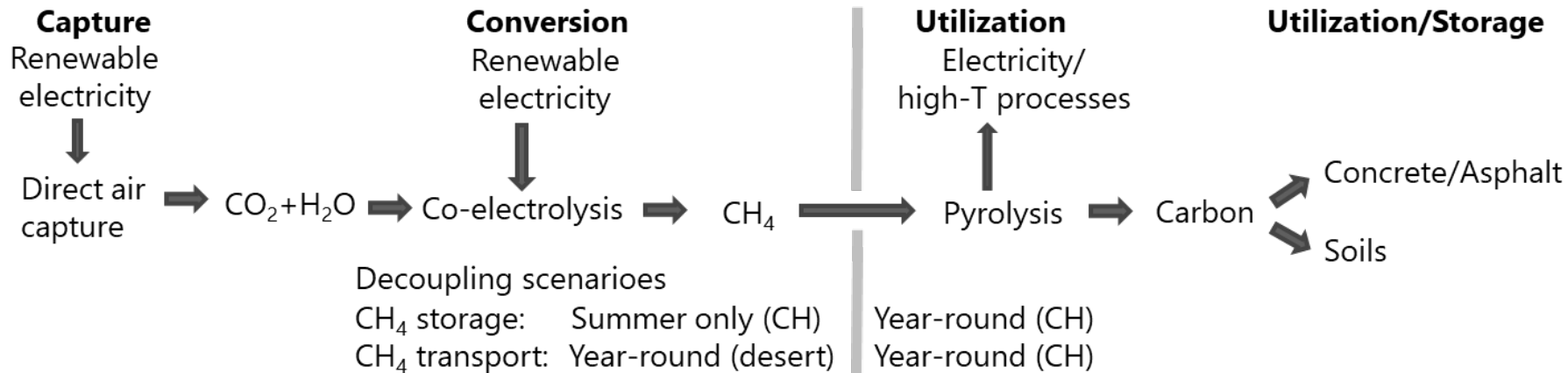


Project work
packages

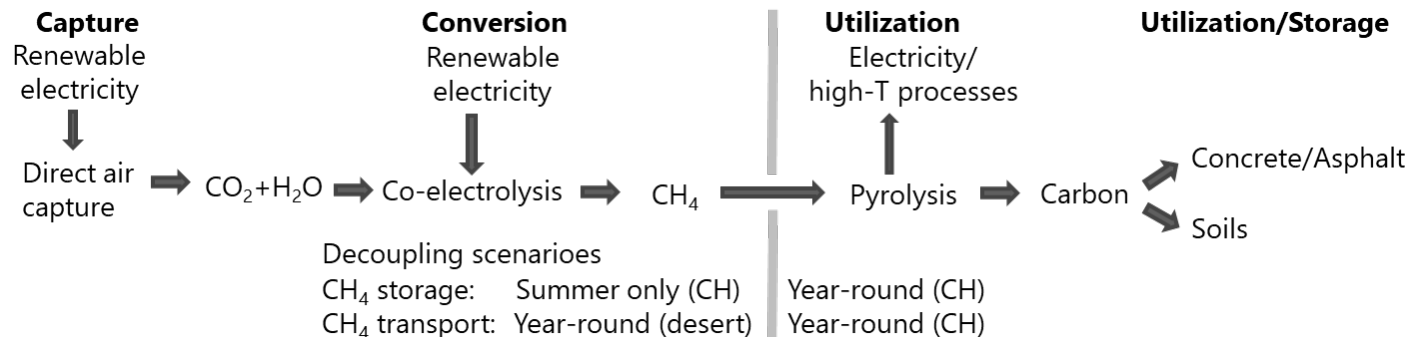
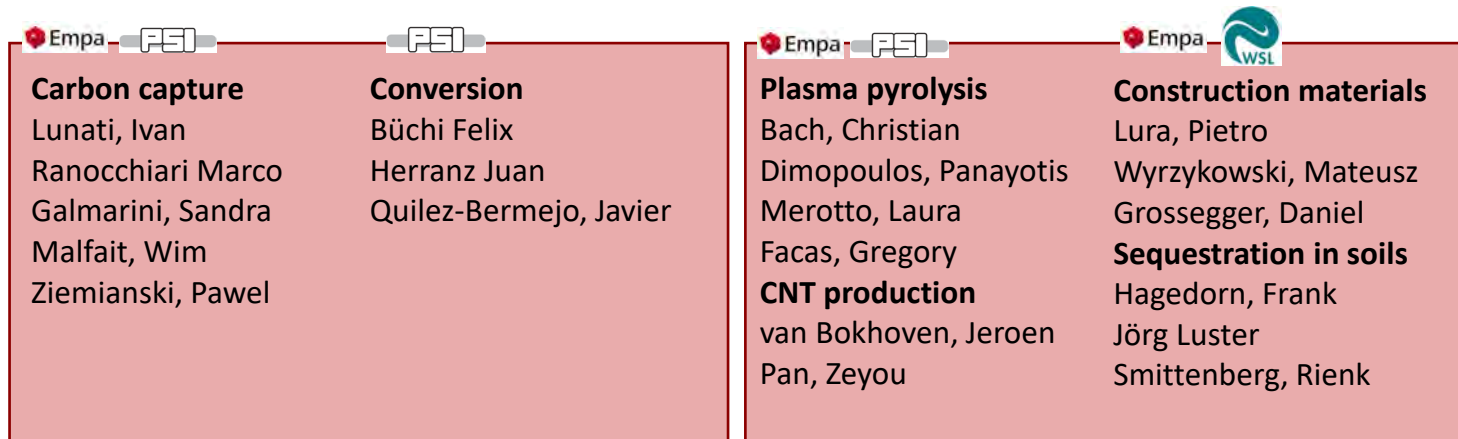


Technical CCUS

A potentially carbon-negative cycle to meet fluctuating energy demands



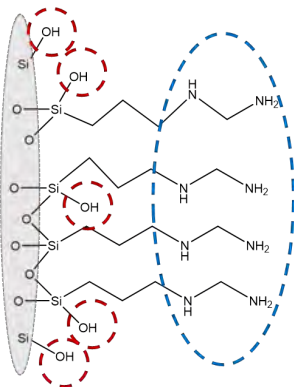
Technical CCUS - Team



Technical-scientific activities

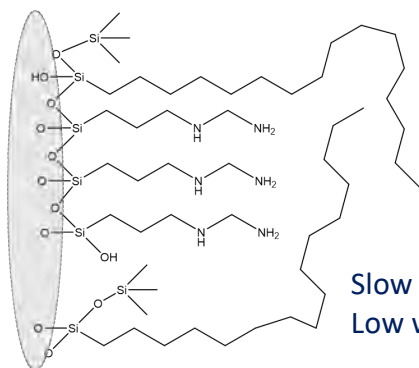
Selective sorbents for Direct Air Capture of CO₂

Standard silica-gel adsorbents

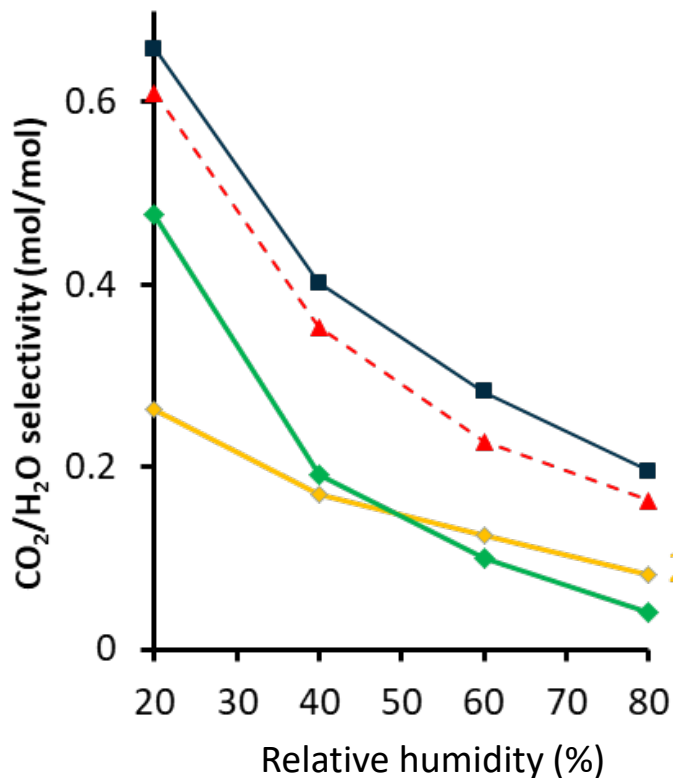


Fast degradation
High water sorption

Hybrid grafting strategy

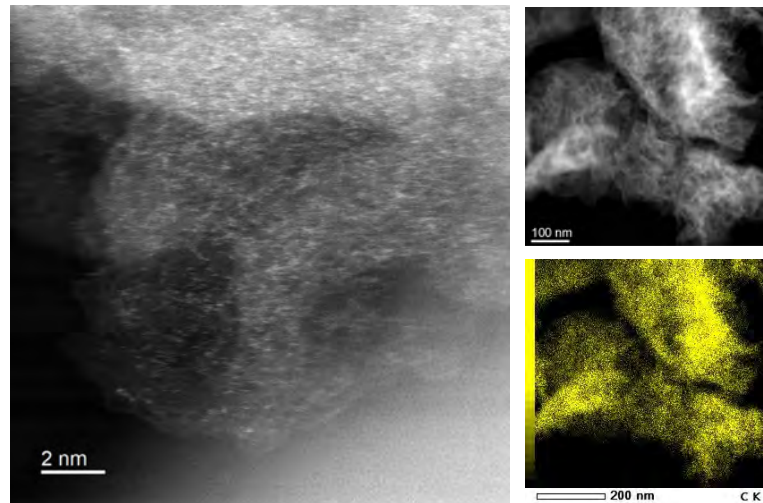
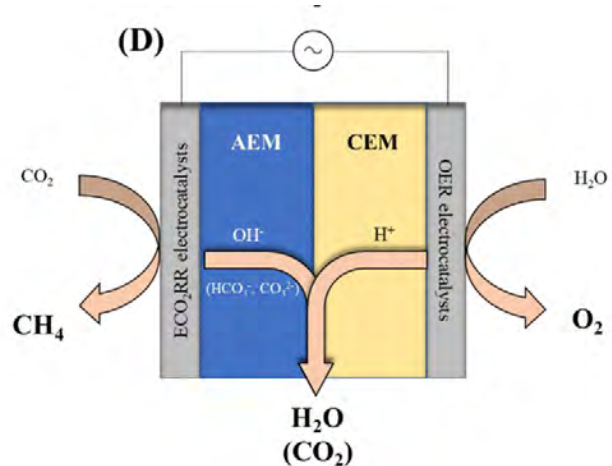


Slow degradation
Low water sorption



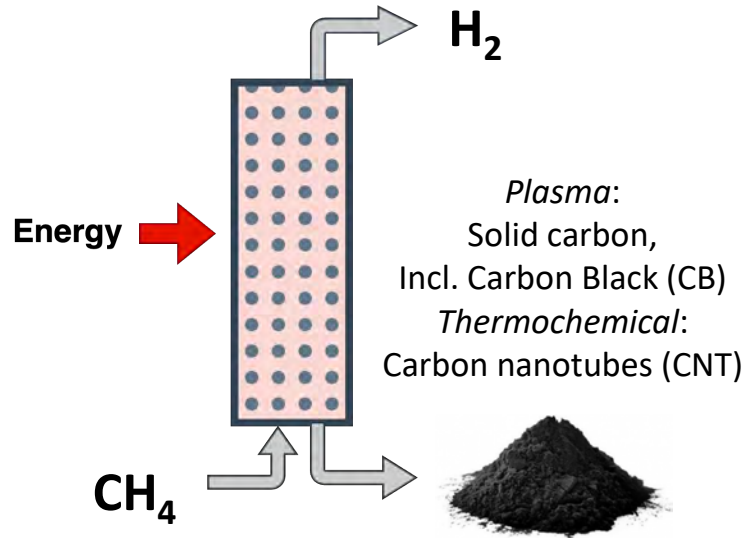
2-amino-C18
Lewatit
2-amino-HDMS
2-amino

Co-electrolysis of CO₂ and water into methane?



- High selectivity for CH₄ over H₂ and CO difficult to achieve
- Cu catalysts appears most promising, but poor reproducibility of literature
- Single atom Cu catalysts on carbon substrates developed within SCENE
- High efficiency for CO production over HER – continued in BFE SWEET ReFuel.ch
- CH₄ selectivity of up to ~30% achieved only in last year of project

Methane pyrolysis



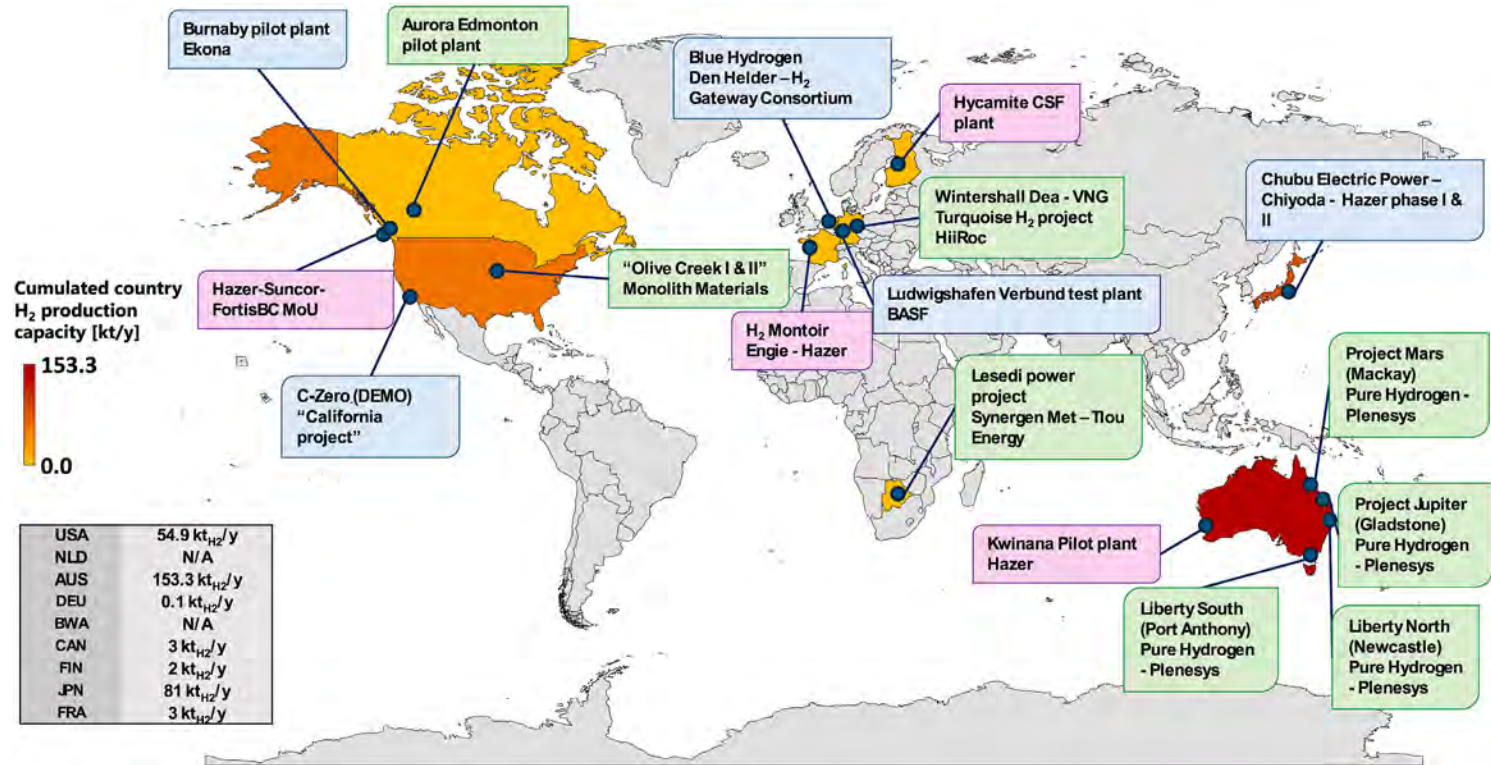
Natural Gas

Biomethane

e-methane

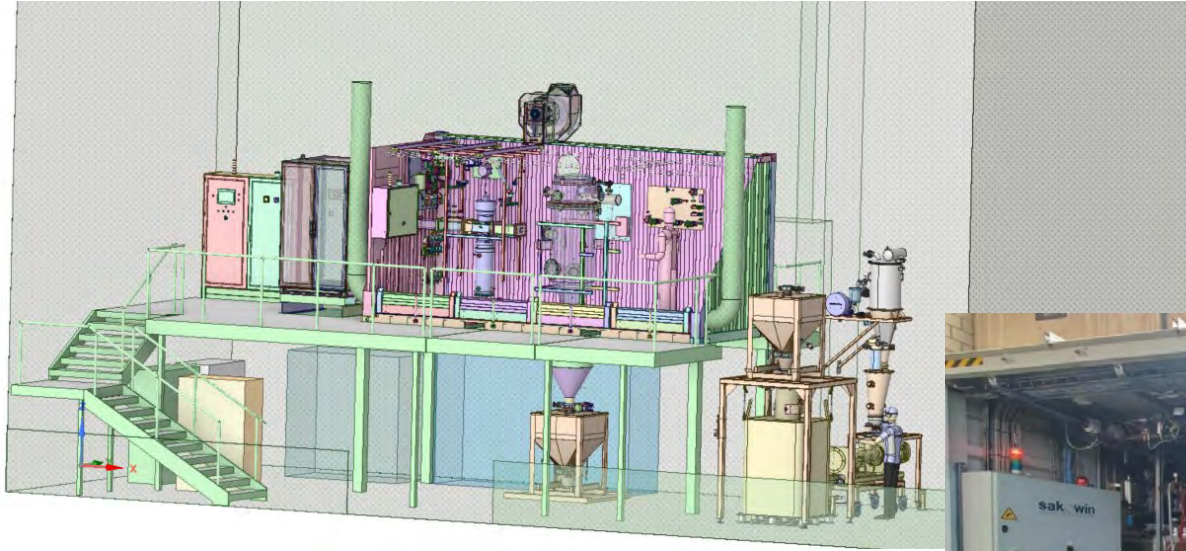
- Conversion of methane into solid carbon (for applications and/or sequestration and H_2 (for energetic use)).
- Thermochemical decomposition requires relatively high temperatures and energy inputs.
- Plasma-based methods only bring up the electron-temperature of the gas and are potentially more effective.

Methane pyrolysis



Current commercial plants projects on Methane Pyrolysis. Plasma technologies are represented in green, thermal technologies in blue, and thermo-catalytic in purple. de Cataldo et al. 2025.

100 kW plasma pyrolysis plant at VZug providing H₂ for the enameling ovens to decarbonize process heat

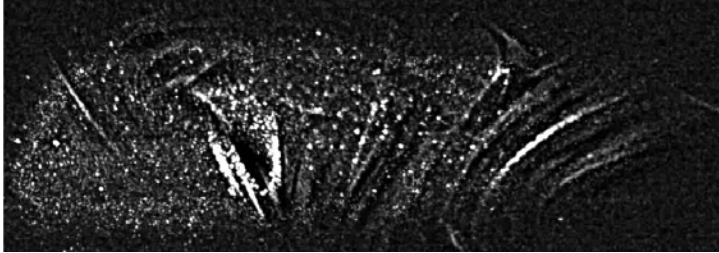


Verein zur Dekarbonisierung der Industrie
www.vzdi.ch/
Scheduled full operation: Q3/Q4 2026



Methane pyrolysis – SCENE Activities

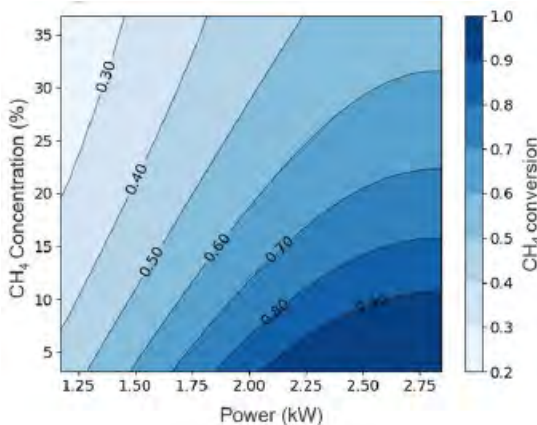
- Carbon particle tracking in the plasma



- Solid-gas separation: >99% retention



- Response surface modeling



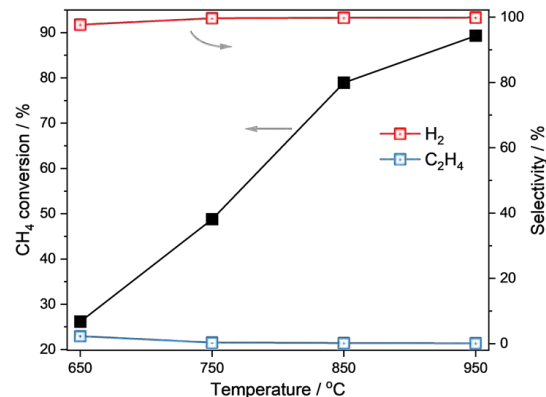
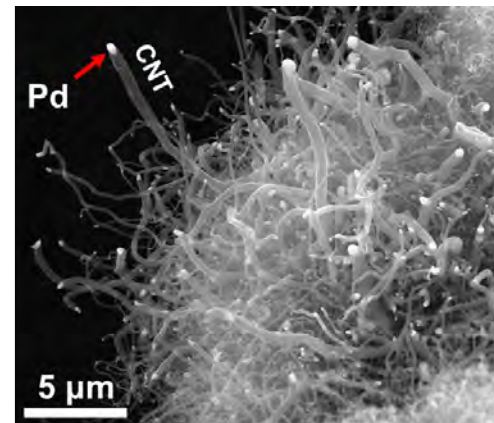
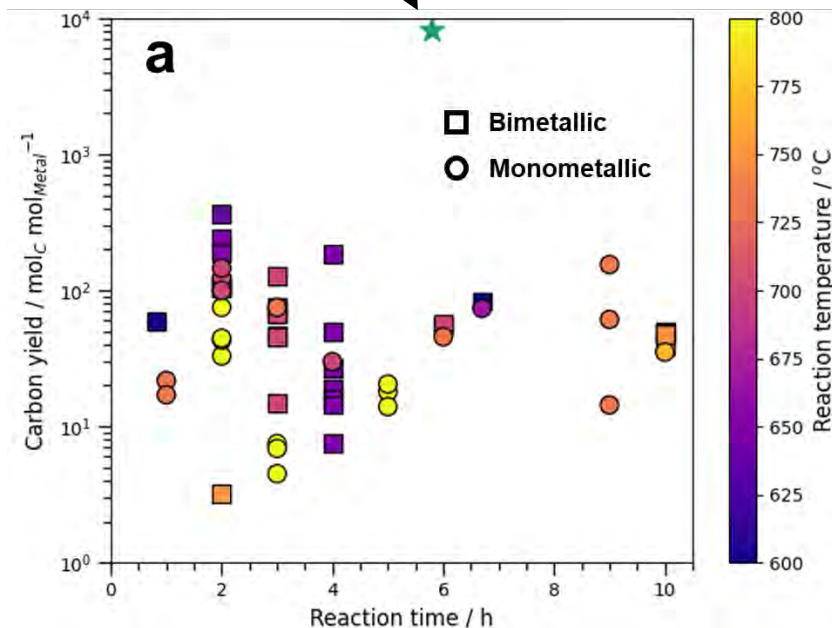
- PAH content reduction

	Untreated Carbon	Treatment at 200 °C, 12hr	Treatment at 400 °C, 2hr
Compound Name	TEQ (g/ton)	TEQ (g/ton)	TEQ (g/ton)
Naphthalene	1.0	0.01	0.00
Acenaphthylene	13	0.01	0.00
Acenaphthene	0.26	0.00	0.00
Fluorene	3.0	0.00	0.00
Phenanthrene	5.5	0.58	0.00
Anthracene	10	0.15	0.00
Fluoranthene	4.6	1.19	0.00
Pyrene	8.8	0.75	0.00
Benz(a)anthracene	31	1.85	0.02
Chrysene	3.5	0.89	0.00
Benzo(b)fluoranthene	47	15.72	0.02
Benzo(k)fluoranthene	21	5.10	0.01
Benzo(a)pyrene	1254	10.48	0.21
Indeno(1,2,3-cd)pyrene	106	17.06	0.02
Dibenzo(ah)anthracene	14	3.80	0.07
Benzo(ghi)perylene	25	3.86	0.00
Sum	1548	61	0.37

Catalytic pyrolysis of CH₄ into carbon nanotubes and H₂

1. The Pd/MgO catalyst achieved a 10x carbon productivity.
2. In the gas products, the H₂ selectivity exceeded 97%.
3. Carbon nanotubes were the predominant solid product.

Our work

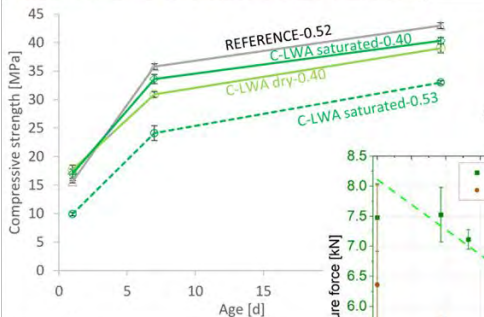
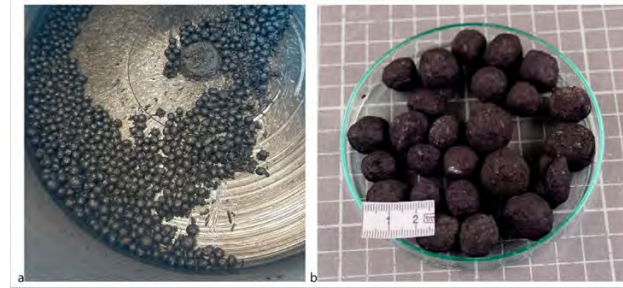


Storage in construction materials

- The large volume of concrete/asphalt is an exceptional reservoir for carbon storage.
- How much carbon can be added without a significant penalty in performance?

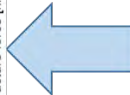
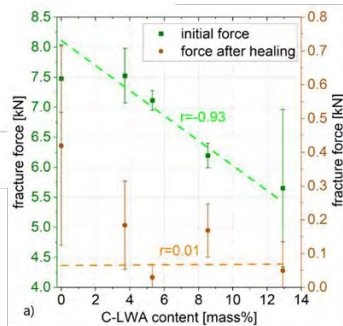


Pelletization of
(bio)char into hard,
light-weight
aggregates



Concrete properties
acceptable with 10%
aggregates

Asphalt properties



Incorporation into
concrete and asphalt

