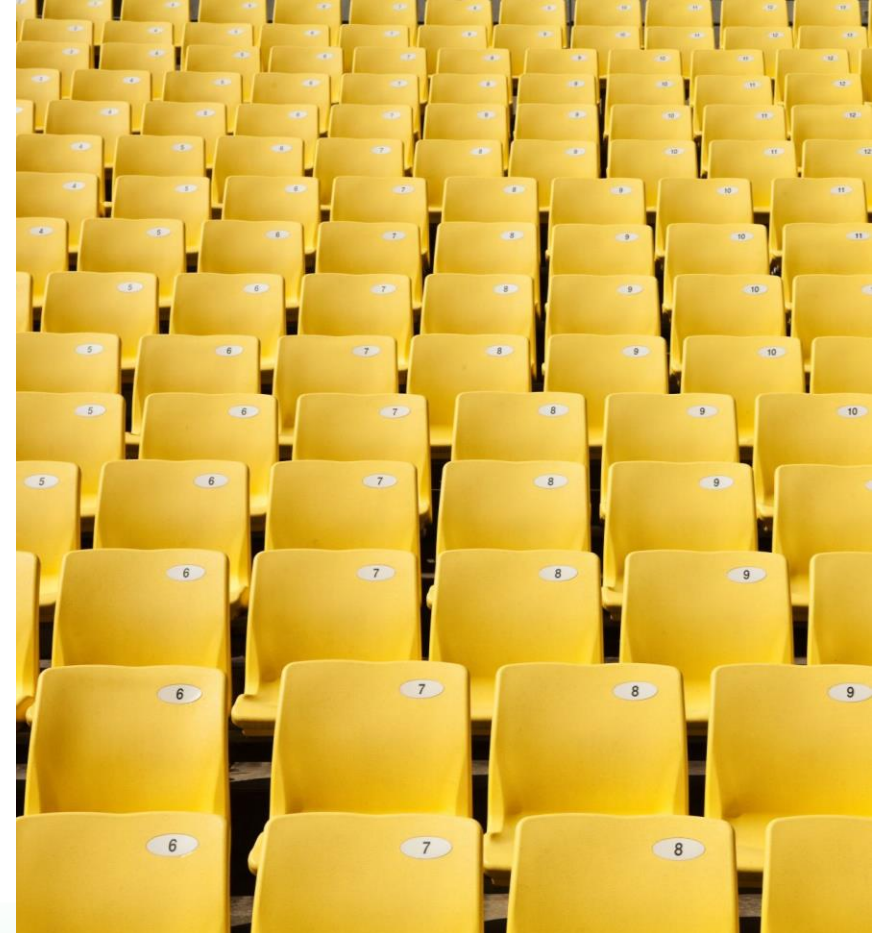




Clean Hydrogen Partnership



H₂ PRODUCTION WITH NEGATIVE CO₂ EMISSIONS

paula.teixeira@tecnico.ulisboa.pt



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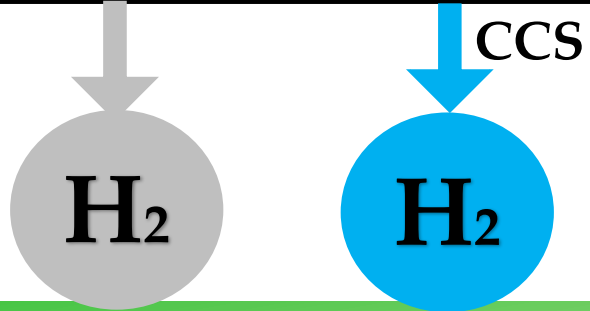


Alternative paths for H₂ production

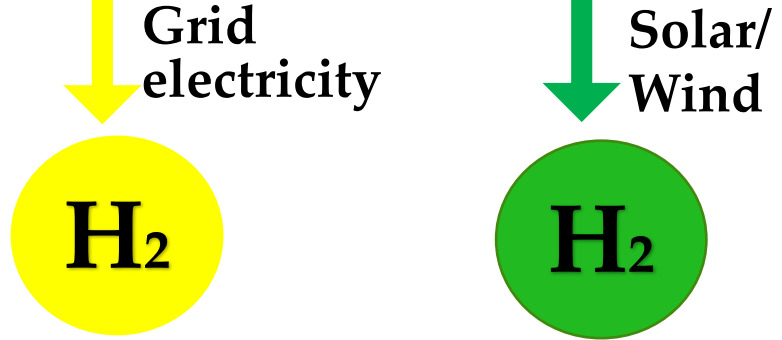
H₂ could be produced using different technologies with associated **TRLs** and **Carbon emissions**

Steam reforming of natural gas (with CCS)
TRL 9 / TRL 7-8
11-17 / 3-9 kg CO₂/kg H₂

Coal gasification (with CCS)
TRL 9 / TRL 6-7
14-31 / 1-10 kg CO₂/kg H₂



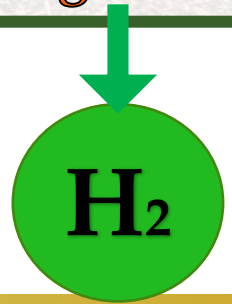
Water electrolysis (solar/ wind energy)
TRL 9
? / 0.5-2.5 kg CO₂/kg H₂



The price of the renewable electricity needs decreases significantly

Biomass gasification (with CCS)
TRL 5-6 / TRL 3-5
0.3-9 / <0 kg Bio - CO₂/kg H₂

Biogas Dry Reforming (with CCS)
TRL 5-6
2.9 / <0 kg Bio - CO₂/kg H₂



Context



Diário da República, 1.ª série

N.º 158

14 de agosto de 2020

Pág. 7

PRESIDÊNCIA DO CONSELHO DE MINISTROS

Resolução do Conselho de Ministros n.º 63/2020

Sumário: Aprova o Plano Nacional do Hidrogénio.

2.3 — POLÍTICAS E MEDIDAS DE AÇÃO

- Promover e incentivar o desenvolvimento e a demonstração de tecnologias de conversão de biomassa por upgrade de biogás, de conversão de biomassa sólida e de resíduos urbanos por gaseificação e....

Bio-waste valorization legislation

- Biogas production should increase after 2023
- In 2027 the subsidy for selling electricity from biogas (anaerobic digestion) will end and biogas producers need alternatives

European Clean Hydrogen Alliance

- iii. Hydrogen Production based on Direct Gasification of Biomass or Waste or other Innovative (non-Electrolysis) Technologies, related Bottlenecks, and their Mitigation

Topic	Bottleneck	Mitigation Measures
Financing & Funding Gaps	Direct gasification is currently not sufficiently acknowledged in relevant regulations, which leads to slow market uptake among waste treatment companies. This lack of clarity creates barriers in other areas (e.g. access to finance, permitting procedures)	The role of non-recyclable waste and biomass in hydrogen production need to be reflected appropriately in all relevant regulations (RED II, waste directive, State Aid Guidelines)
Administrative & Regulatory		
Other Areas	Underestimated advances in Research, Development in thermal treatment of waste for clean Hydrogen and Execution regarding the integration of new, novel as well as mature components for new applications	Increased efforts needed to support the alternative technologies and demonstration projects already set-up by EU Universities such as KTH Stockholm, TU-Freiberg, IEC, EVT, and by dedicated corporates.

- Lack of regulations especially in waste market
- Increasing efforts are needed to the dissemination of research achievements

14.6.2018

EN

Official Journal of the European Union

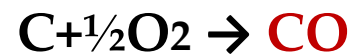
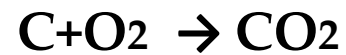
DIRECTIVE (EU) 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 30 May 2018

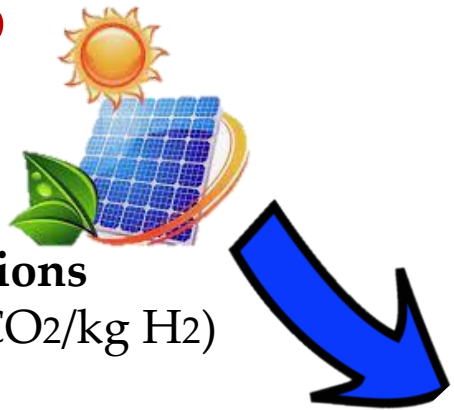
amending Directive 2008/98/EC on waste

Hydrogen production from biomass gasification or biogas dry reforming followed by WGS with in-situ carbon capture

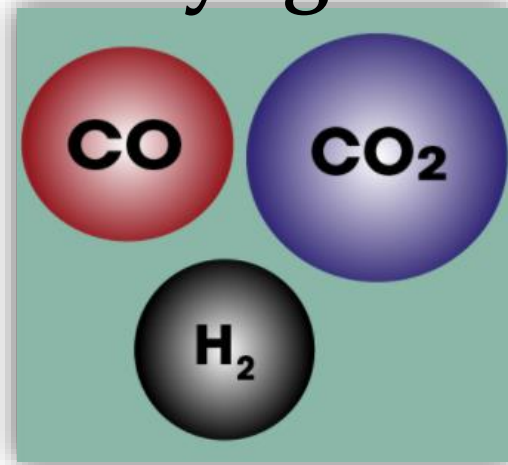
Biomass gasification with CCS



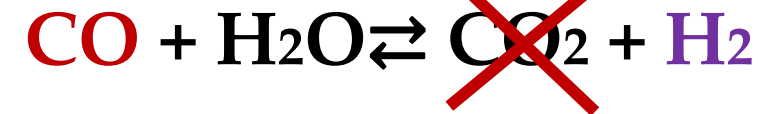
- Negative emissions (-11.7 to -17.5 kg CO₂/kg H₂)



Syngas

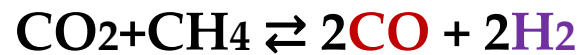


Syngas Upgrade

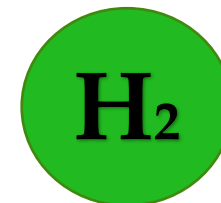


Sorption Enhanced Water Gas Shift (SEWGS)

Biogas dry reforming



- Less Energy Intensive



- Negative emissions technology
- Increase of H₂ production yield with CCS



Thank you!

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DE ENGENHARIA QUÍMICA
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