TECHNISCHE UNIVERSITÄT WIEN

Energy Economics Group

Production costs analysis of increased renewable methane output through CO_2 utilization

13. Internationale Energiewirtschaftstagung (IEWT)

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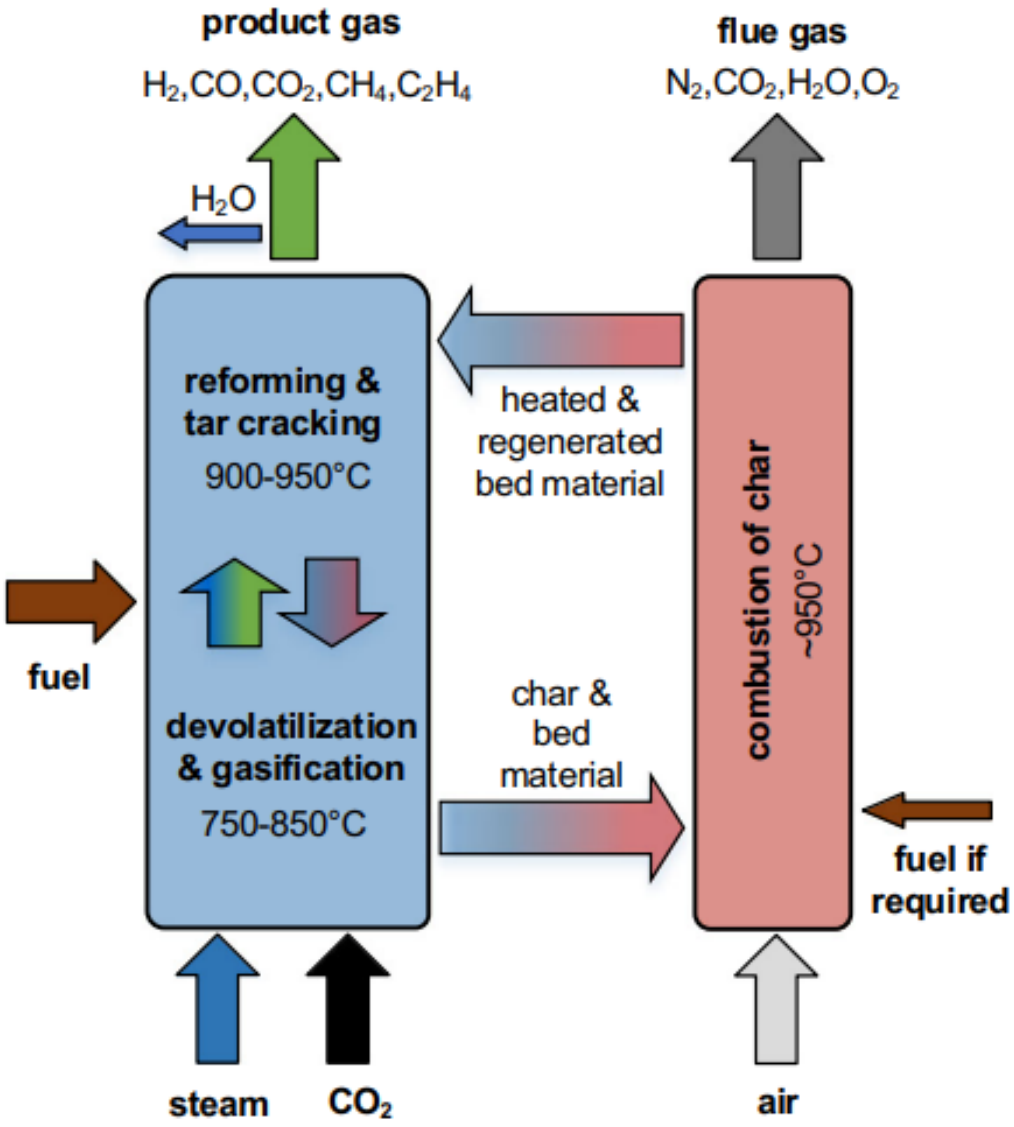
Importance of biomass-based gases

- Gaseous energy carriers are used for many purposes
- Usage for processes, which are difficult to electrify
- EU depended on imports of natural gas: 82% were imported in 2020
- Green gases are substitutes for natural gas (flexibility)
- Contribution to emission reduction (industy, transport, agriculture)
- Energy storage

Biomass gasification



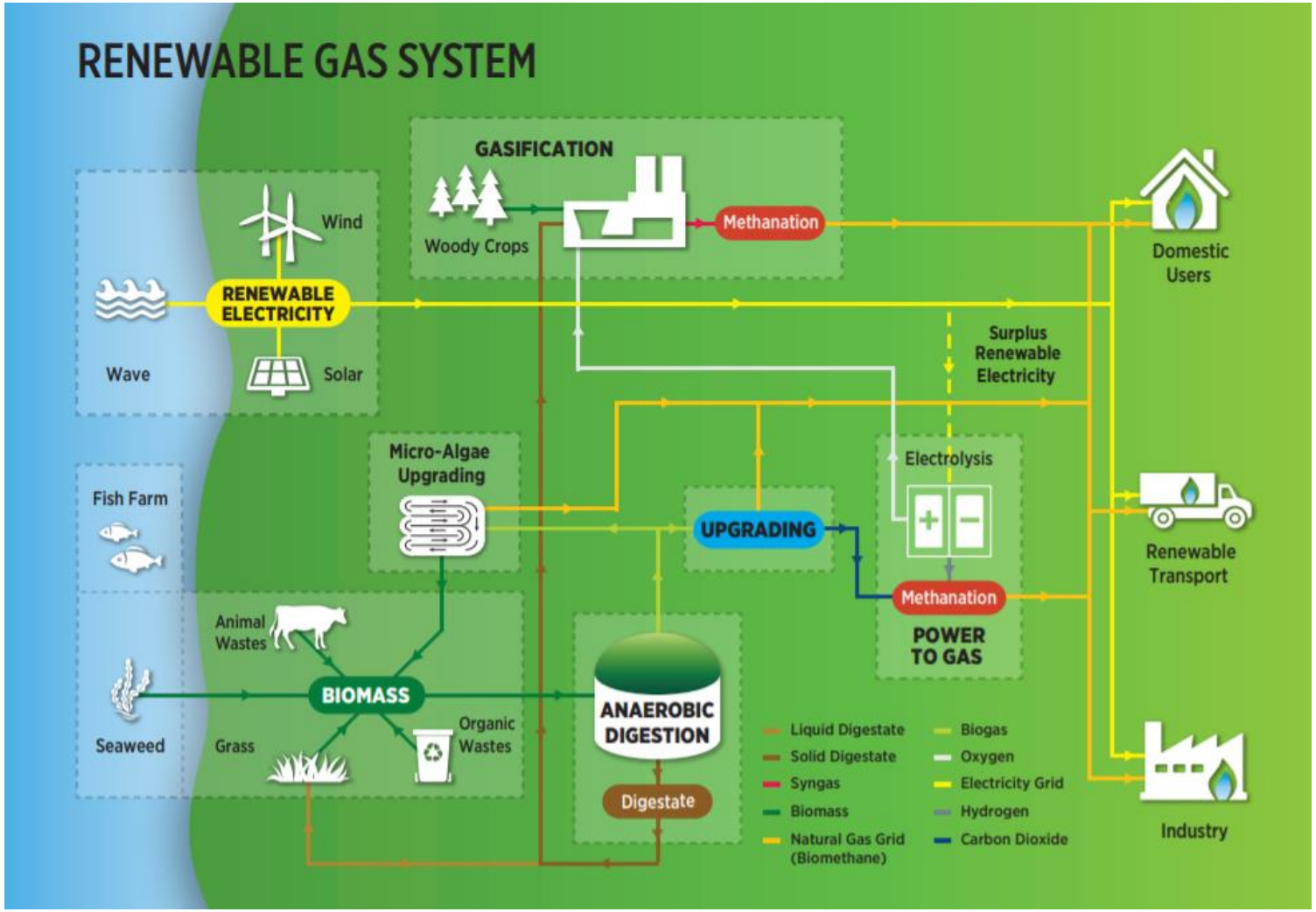
Mauerhofer et al. 2021

Methanation

$CO_2 + 4H_2 \leftrightarrow CH_4 + 2H_2O$

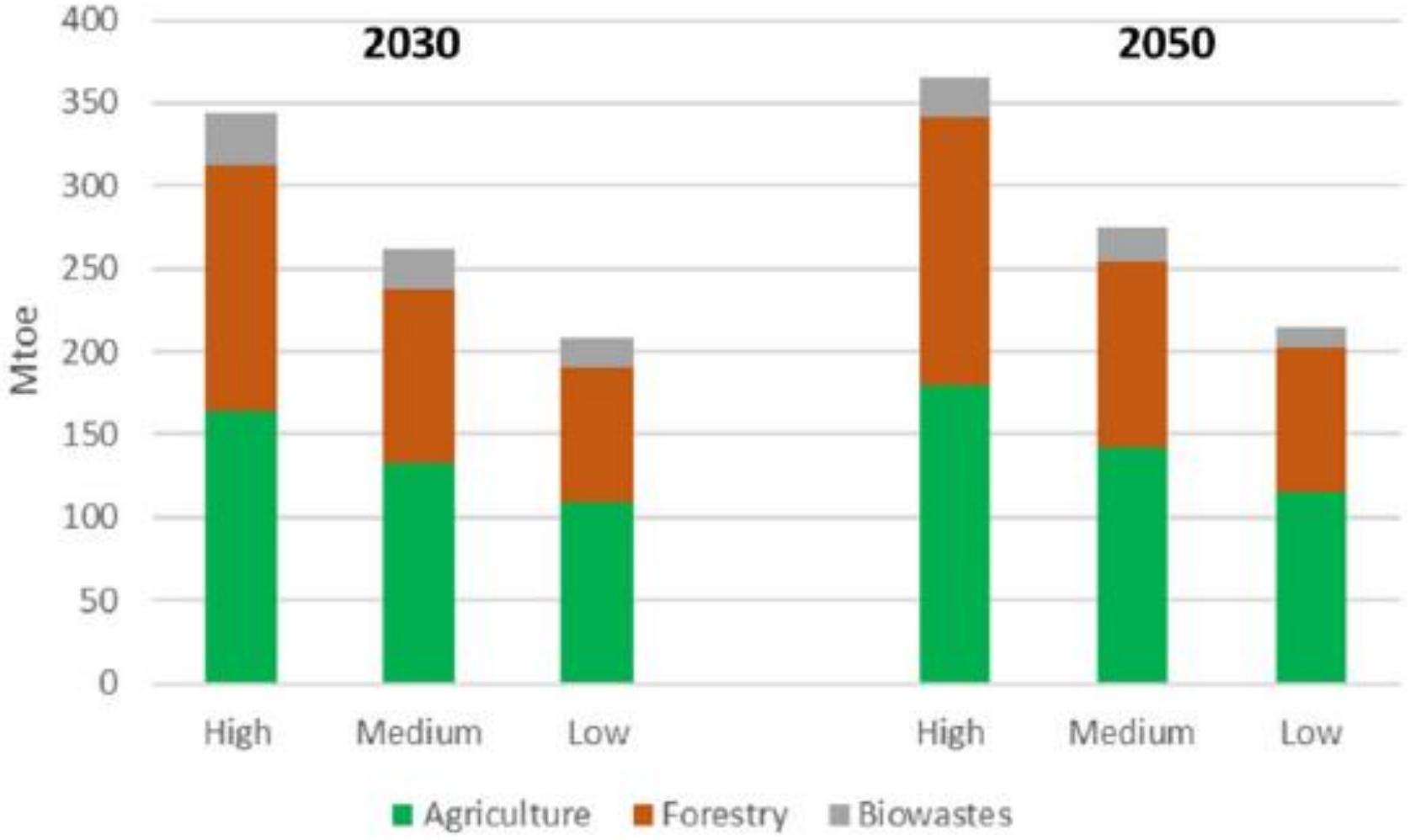
$CO + 3H_2 \leftrightarrow CH_4 + H_2O$

Carbon utilization
~ 35-40%



Source: Green Gas Brochure, www.MaREI.ie

Biomass resources



Feedstock potentials in the former EU-28 with focus on biomass waste and residues. Source: Imperial College London 2021

Advanced biofuels
2030: 46-97 Mtoe
2050: 71-176 Mtoe

Increase to approximately:
2030: 92 – 94 Mtoe
2050: 142 – 352 Mtoe
with **CO_2 utilization**

Final energy consumption of transport sector (EU)
2019: ~ 290 Mtoe

Methods

Economic assessment

- Production costs
  - $c_{fuel} = \frac{CRF*I_0+C_{OF}+C_{misc}}{FLH} + \frac{P_B}{LHV*\eta} + c_{var}$
  - $c_{H_2} = \frac{CRF*I_0+C_{om}}{FLH} + \frac{c_{ele}}{\eta}$
- Scaling method
  - $C_1 = C_0 * \left(\frac{S_1}{S_o}\right)^f$

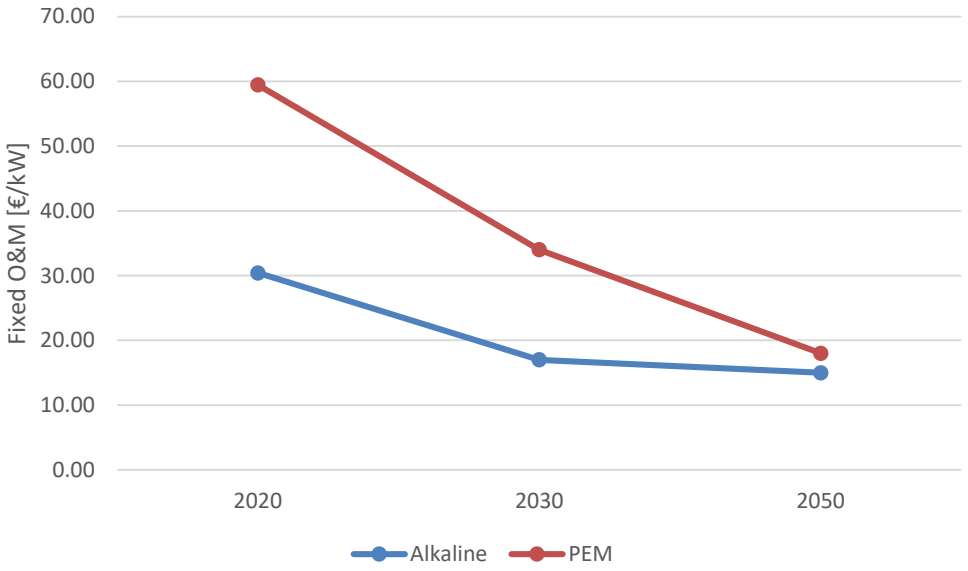
c_{fuel} = levelized cost of fuel production, CRF = capital recovery factor, C_{OF} = fixed operating cost [€/ kW], C_{misc} = other capacity related cost, P_f = feedstock price, LHV = lower heating value, η = energy efficiency, c_{var} = variable cost [€/ kWh], C_0 = reference price for scale 0, S_o = base scale, f = scaling factor

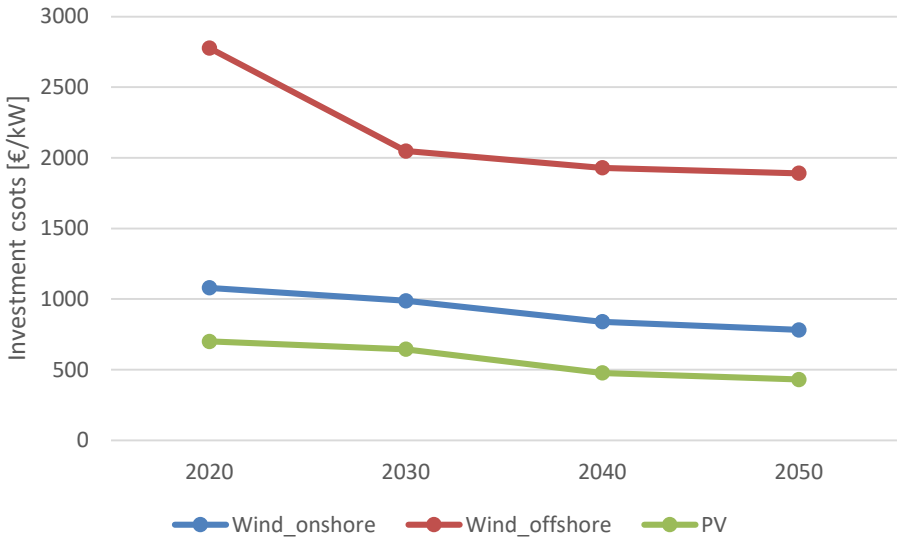
Parameters

	SNG	Biomethane	Alkaline electrolyzer		PEM electrolyzer	
Year			2020	2050	2020	2050
Discount rate	5%	5%	5%	5%	5%	5%
Transport distance	75 km	10 km	/	/	/	/
Energy efficiency	63%	42-69%	42-**67** %	> 74 %	40-**67** %	> 74%
Plan/electr. Capacities [MW]	100 MW	8 MW				
kWh H2/ kWh added	**1.26**	**0.7-1**				
Investment cost €/kW	4680-7580	1900-3780	437-875	< 200	613-1225	<200

Sources: Hofbauer 2020, Holmgren 2015, Billig und Thraen 2017, Thunman 2018, IRENA 2020

Decline in H2 production costs

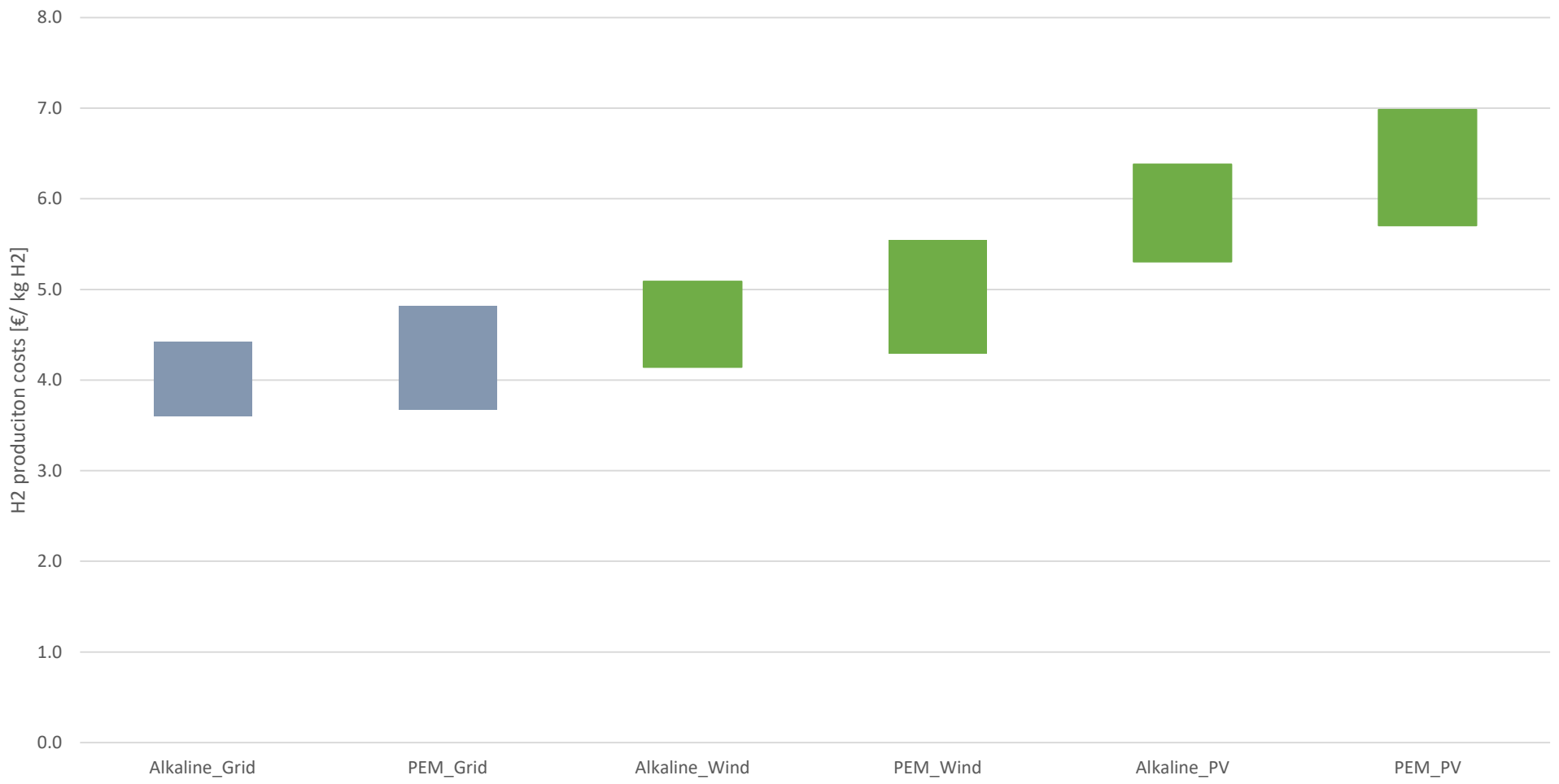




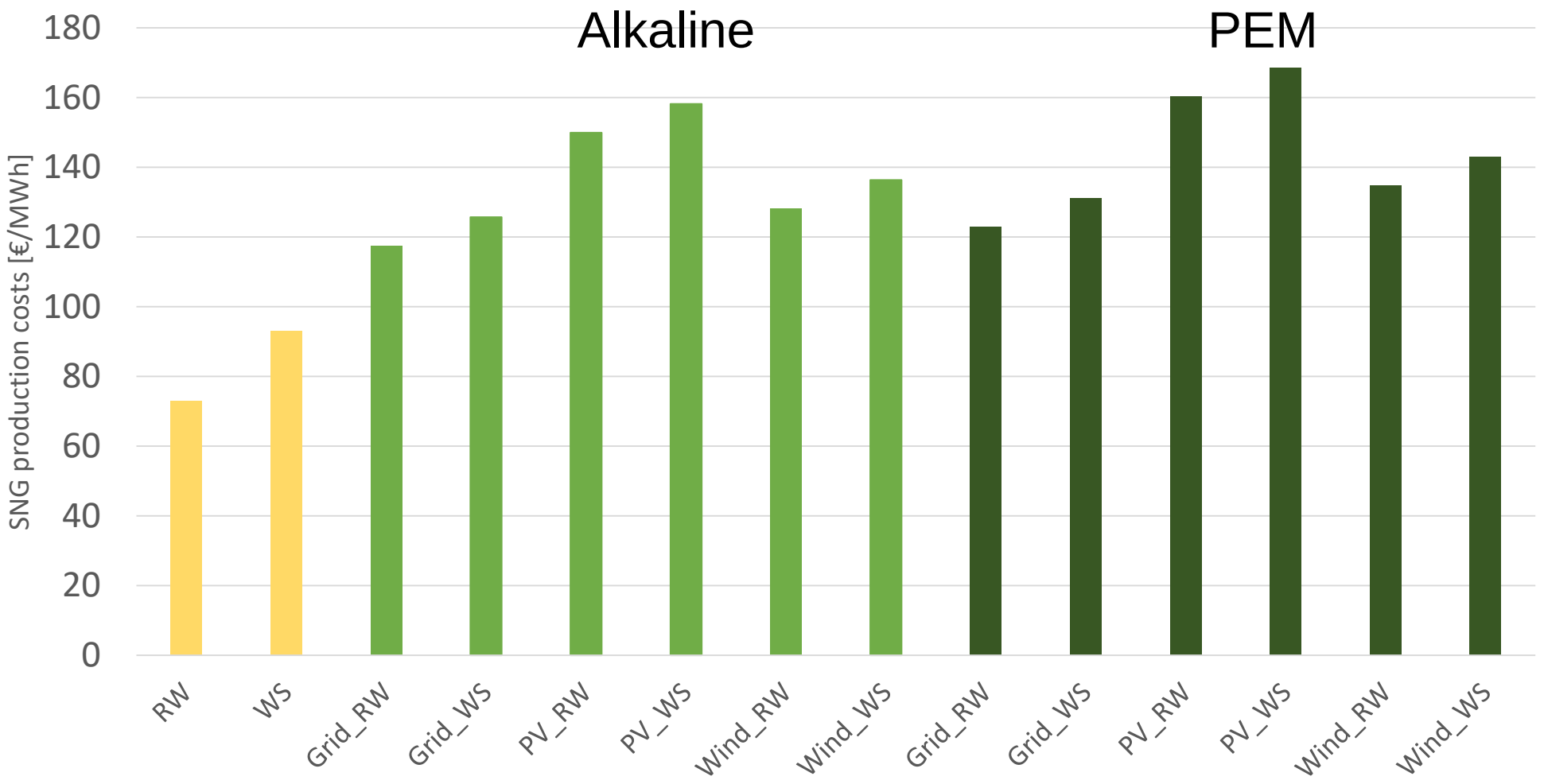
Source: Asset 2018

Results

Hydrogen production costs (2020)

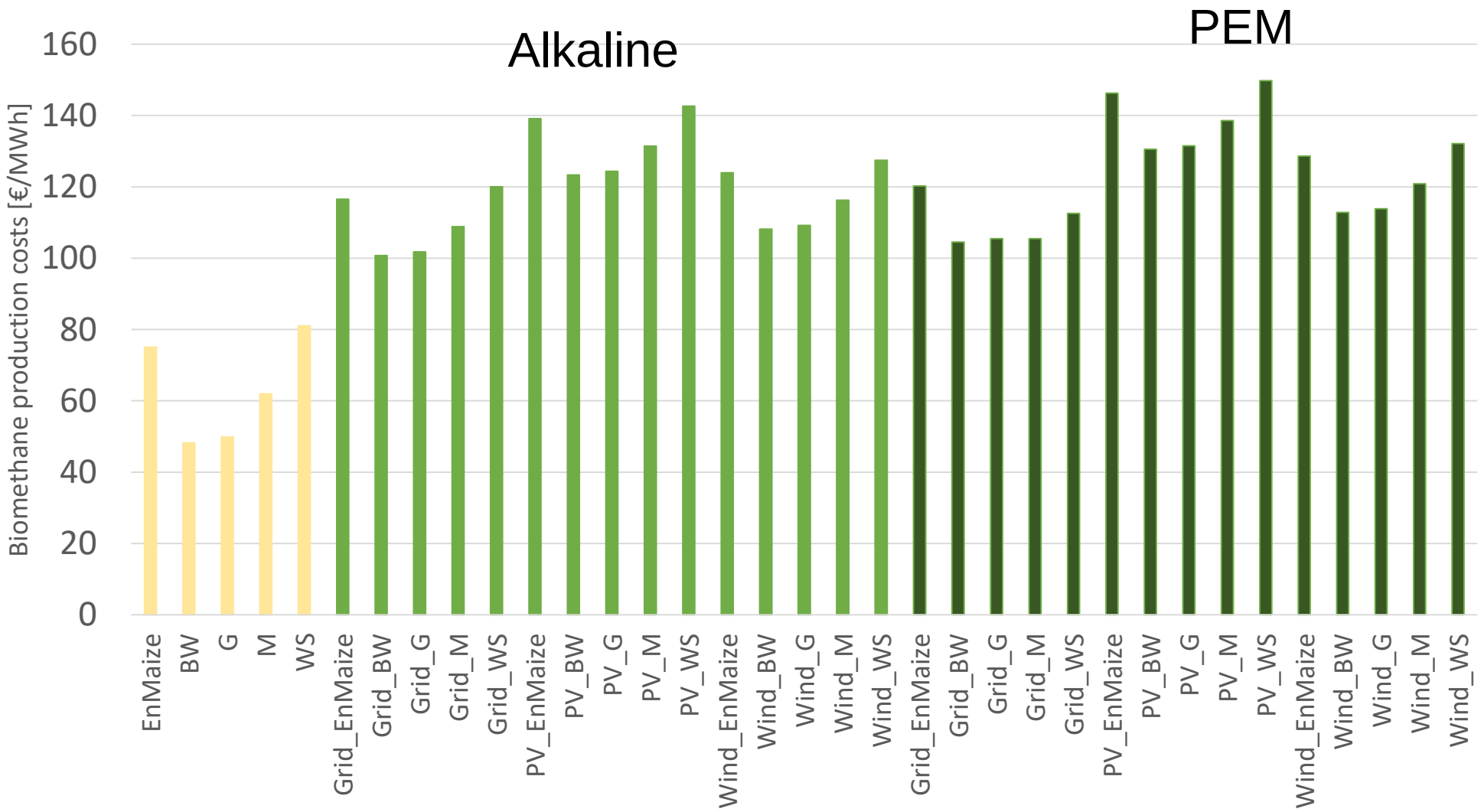


Enhanced synthetic natural gas output



RW=residual wood, WS=wheat straw, PV=photovoltaics, PEM = Proton-exchange membrane

Enhanced biomethane output



EnMaize=Energy maize, BW=biowaste, G=grass, M=manure, WS=wheat straw, PV=photovoltaics

Conclusions

- Biomass is a limited resource
- Output of renewable methane can be doubled with CO_2 utilization
- Choice of feedstock has a significant influence on the production costs
- Cost reductions of hydrogen in the future
  - will lead to cost reductions for CO_2 utilization

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