TECHNOLOGY FACTSHEET

STEAM METHANE REFORMING (SMR) FOR HYDROGEN PRODUCTION

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Sector	Hydrogen
ETS / Non-ETS	ETS
Type of Technology	SMR-based hydrogen production without CCS
Description	Steam methane reforming (SMR) is a method that can be used for producing hydrogen from natural gas. This is achieved in a processing device called a reformer which reacts steam at high temperature with the gas. SMR uses the endothermic reaction $CH_4 + H_2O \rightleftharpoons CO + 3H_2$.
TRL level 2020	TRL 9 IEA (2017) reports 100.000 Nm3/h. at 10,8 MJ/Nm3, this translates to a capacity of precisely 300 MW hydrogen energy output. Progress ratio is found in Thomas (2009)

TECHNICAL DIMENSIONS

	Functional Unit		Value and Range		
Capacity	MW				*300.00*
			300.00	*-*	*300.00*
Potential	MW	NL		*unlimited*	
			-	*-*	*-*
Market share	%				*-*
			Min	*-*	*Max*
Capacity utlization factor				1.00	
Unit of Activity	PJ/year				
Technical lifetime (years)				25.00	
Full-load running hours per year				8,322.00	
Progress ratio				0.95	
Hourly profile	No				
Explanation	IEA (2017) reports 100.000 Nm3/h. at 10,8 MJ/Nm3, this translates to a capacity of precisely 300 MW hydrogen energy output. Progress ratio is found in Thomas (2009)				

COSTS

Year of Euro	2015									
	Euro per Functional Unit	Current			2030			2050		
Investment costs per year	mln. € / MW			0.74			0.74			0.74
		0.74	-	0.74	0.74	-	0.74	0.74	-	0.74
Other costs per year	mln. € / MW			-			-			-
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Fixed operational costs per year (excl. fuel costs)	mln. € / MW			0.03			0.03			0.03
		0.03	-	0.03	0.03	-	0.03	0.03	-	0.03
Variable costs per year	mln. € / MW			0.24			0.24			0.24
		0.24	-	0.24	0.24	-	0.24	0.24	-	0.24
Costs explanation	Data in NTNU(2016) is based on a different size plant, and the numbers here are scaled to represent the same size plant as in IEA (2017). All costs excluding fuel costs. Sinnot(2009) finds a higher (per kg H2 output) value for investment costs, which can at least in part be explained by the use of data for a smaller size plant. In these figures, the OPEX costs amount to 3,6 % of the CAPEX costs. Conventional plants (such as SMR) benefit from economy of scale, so you can use a scale-up factor of 0.8 [Sinnott et al., 2009] when estimating the cost of a larger scale plant. All values based on LHV. Variable costs include here raw water make-up, catalysts and chemicals. Cost developments are taken relative to base year, and are found in Vita (2018). Cost for CO2 capture are included.									

ENERGY IN- AND OUTPUTS

	Energy carrier	Unit	Current			2030			2050		
Energy carriers (per unit of main output)	*Main output:* Hydrogen	PJ			-1.00			-1.00			-1.00
			-1.00	-	-1.00	-1.00	-	-1.00	-1.00	-	-1.00
	Electricity	PJ			-0.03			-0.03			-0.03
			-0.03	-	0.00	-0.03	-	0.00	-0.03	-	0.00
	Natural gas resource (gas fields)	PJ			1.42			1.42			1.42
			1.04	-	1.42	1.04	-	1.42	1.04	-	1.42
		PJ			-			-			-
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Energy in- and Outputs explanation	Production of hydrogen; 10^5 Nm3/h give 10,8*10^5*24*365*0,95 MJ = 8,99 PJ/y. The 0,95 factor is to account for active running hours per year. Other numbers are taken from IEA (2017) and NTNU (2016) and scaled accordingly. The NTNU study reports on a energy efficiency of 0,82, but based on their own reported values of in,- and outlet I find an energy efficiency of 0,96. A plant with an average power of 300*0,95 MW gives 8,99 PJ/year, and so all numbers are scaled by 8,99 to give a per PJ result. The 0.95 factor accounts for the utilization rate.										

MATERIAL FLOWS (OPTIONAL)

	Material	Unit	Current			2030			2050		
Material flows					-			-			-
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
					-			-			-
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Material flows explanation											

EMISSIONS (Non-fuel/energy-related emissions or emissions reductions (e.g. CCS)

	Substance	Unit	Current			2030			2050		
Emissions	CO2	Mton			-			-			-
			-	-	-	-	-	-	-	-	-
					-			-			-
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
					-			-			-
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
					-			-			-
			Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*
Emissions explanation	These emissions are calculated by Opera from the fuel input, and therefore considered zero for this input field.										

OTHER

		Current			2030			2050		
Other				-			-			-
		Min	-	*Max*	*Min*	-	*Max*	*Min*	-	*Max*

REFERENCES AND SOURCES

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