Supplemental Information

Renewable-power-assisted production of hydrogen and liquid hydrocarbons from natural gas: techno-economic analysis

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Table S1 Important stream information of configuration 1 - SOEC (NG1)

Stream	100	101	102	103	104	105	106	107	108
Temperature [°C]	50	234.6	650	1050	210	210	210	60	79
Pressure [bar]	30	30	29	28	26	24	22	20	30
Mass flow [t/h]	104.7	113.9	311.9	437.9	320.9	186.1	131.8	86.93	93.34
Molar flow [kmol/h]	6000	6322	16146	30034	23603	10835	5782	369	3097
Mole fractions									
CO	0.000	0.000	0.025	0.247	0.315	0.271	0.201	0.009	0.127
H_2	0.000	0.000	0.091	0.468	0.598	0.514	0.381	0.009	0.199
H_2O	0.000	1.000	0.348	0.219	0.003	0.004	0.004	0.014	0.004
CH_4	0.950	0.000	0.411	0.005	0.007	0.032	0.075	0.004	0.129
C_2- C_4	0.045	0.000	0.007	0.000	0.000	0.008	0.020	0.016	0.036
C_{5+} (alkanes)	0.000	0.000	0.002	0.000	0.000	0.003	0.005	0.801	0.008
C_{5+} (alkenes)	0.005	0.000	0.000	0.000	0.000	0.001	0.001	0.078	0.002
CO_2	0.000	0.000	0.117	0.061	0.078	0.168	0.313	0.068	0.494
N_2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table S2 Important stream information of configuration 2 - E-SMR (NG1)

Stream	100	101	102	103	104	105	106	107	108	109	110
Temperature [°C]	50	234.6	500	850	300	300	210	210	210	60	79
Pressure [bar]	30	30	29	28	5	28	26	24	22	20	30
Mass flow [t/h]	104.7	577.5	995.2	995.2	20.41	974.8	545.8	419.3	368.9	80.07	313.1
Molar flow [kmol/h]	6000	32054	48456	61744	10123	51622	28744	16724	11966	362	8921
Mole fractions											
CO	0.000	0.000	0.008	0.114	0.000	0.136	0.244	0.167	0.092	0.005	0.044
H_2	0.000	0.000	0.061	0.364	1.000	0.240	0.464	0.317	0.176	0.005	0.068
H_2O	0.000	1.000	0.632	0.387	0.000	0.463	0.003	0.004	0.004	0.008	0.004
CH_4	0.950	0.000	0.157	0.026	0.000	0.031	0.055	0.106	0.156	0.011	0.194
C_2- C_4	0.045	0.000	0.003	0.000	0.000	0.000	0.000	0.005	0.010	0.008	0.014
C_{5+} (alkanes)	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.002	0.004	0.757	0.005
C_{5+} (alkenes)	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.071	0.001
CO_2	0.000	0.000	0.138	0.109	0.000	0.131	0.233	0.399	0.557	0.135	0.670
N_2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Table S3 Water balance in both configurations (NG1)

Water stream [t/h]	Config 1 - SOEC	Config 2 - E-SMR
Water demand in Reformer	113.7	577.5
Water demand in SOEC	206.3	0
Retrieved water from syngas	116.8	431
Retrieved water from product	126.6	119.7
Unconverted in SOEC	40.7	0
Net demand	35.9	26.8

Table S4 List of direct and indirect costs as a fraction of purchased equipment cost[1]

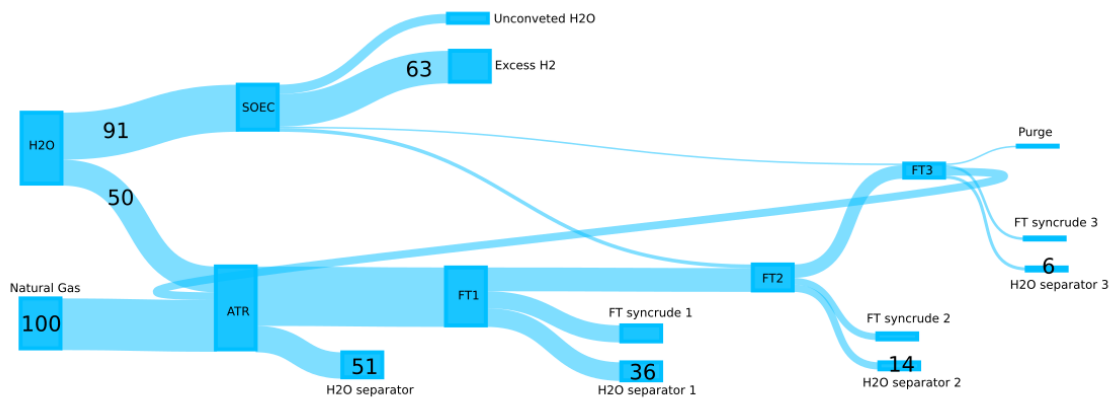| Direct Costs	Fraction of purchased equipment
Purchased equipment installation	0.47
Instrumentation&Controls(installed)	0.36
Piping (installed)	0.68
Electrical systems (installed)	0.11
Buildings (including services)	0.18
Yard improvements	0.10
Service facilities (installed)	0.55
Total direct costs	**2.45**
Indirect Costs	
Engineering and supervision	0.33
Construction expenses	0.41
Legal expenses	0.04
Contractor's fee	0.22
Contingency	0.44
Total indirect costs	**1.44**

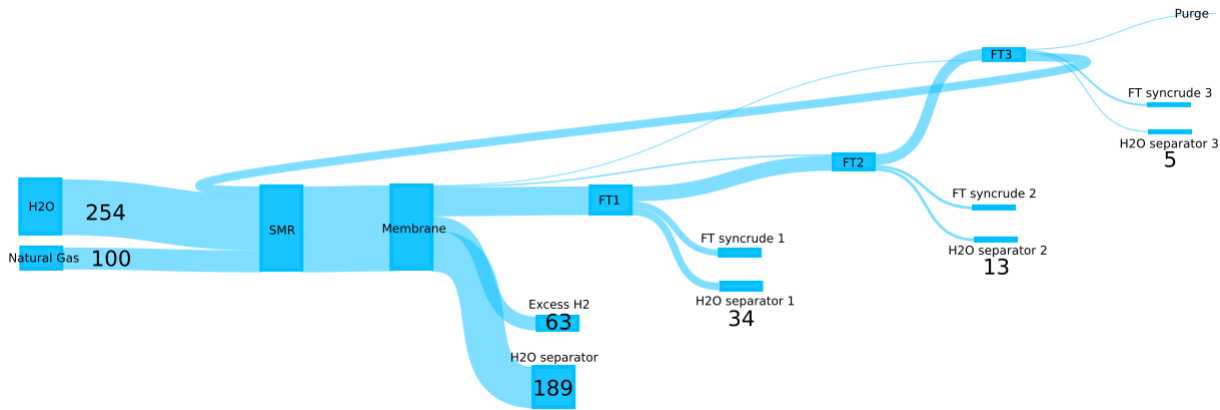Fig. S1 Hydrogen flow of configuration 1. The basis is 100 hydrogen present in the natural gas

Fig. S2 Hydrogen flow of configuration 2. The basis is 100 hydrogen present in the natural gas

Notes and references

1 M. S. Peters, K. D. Timmerhaus and R. E. West, *Plant Design and Economics for Chemical Engineers, 5th ed*, McGraw-Hill Professional: New York, 2002.