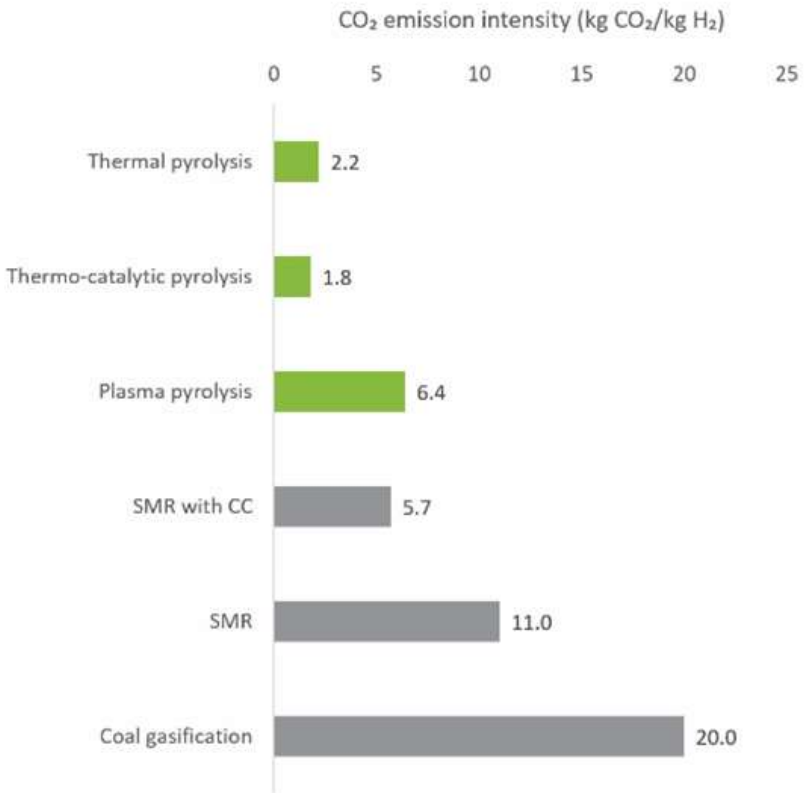
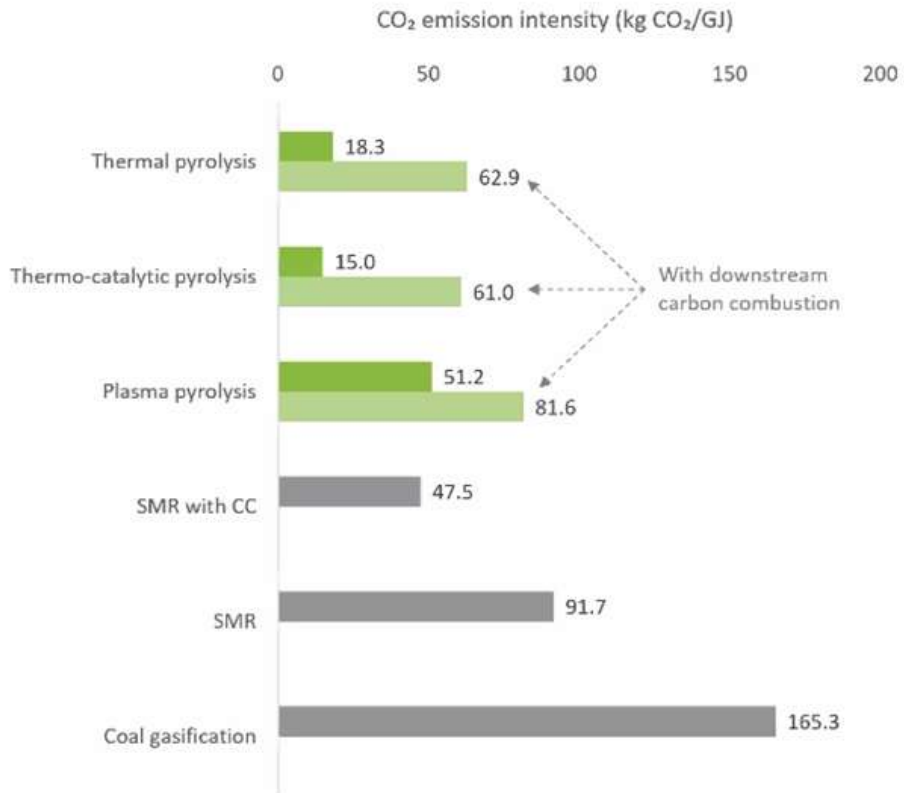
Catalytic cracking of methane to produce H_2 and C

Pyrolysis produces 84% lower CO_2 than SMR





Source: CEEW analysis; Blank and Molly 2020; Howarth 2021

Note: Plasma pyrolysis uses grid emission factors in the presented case

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Details from CEEW report

Figure ES1 Thermal pyrolysis provides the lowest LCOH among all the available technologies

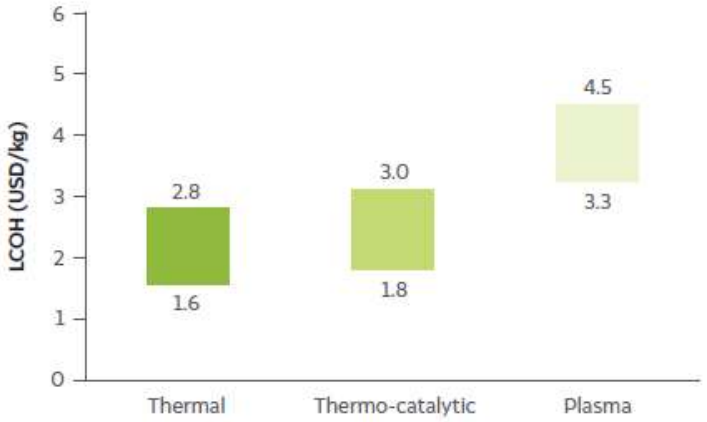


Figure ES2 Hydrogen from natural gas pyrolysis is cheaper than hydrogen from electrolysis and comparable with SMR with CCS

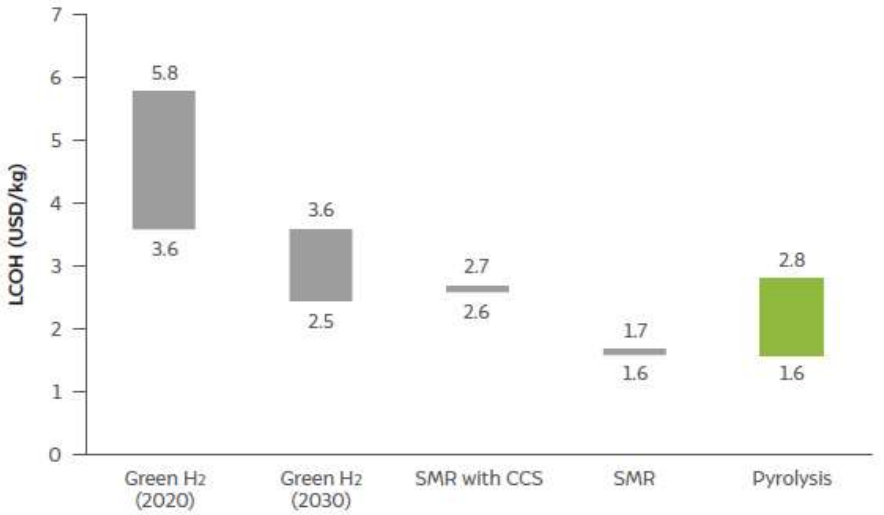
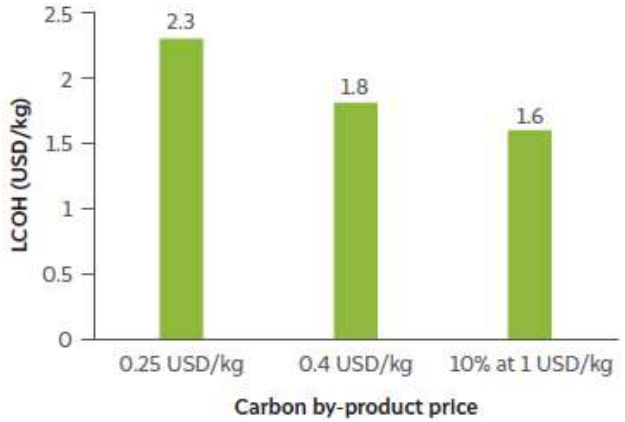


Figure 11 Utilising thermo-catalytic pyrolysis could allow for a much higher value of carbon by-product

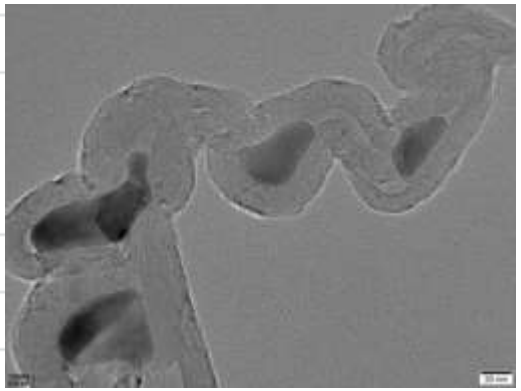


90% of C valued at 0.4 USD/kg

- Based on C selling price of 0.4 to 0 USD/kg
- NG price assumed to be 8USD/MMBtu
- Upper and lower limit based on various parameters
- For SMR, operational and capacity utilization, for pyrolysis, selling price of C

	Feed		Products	
	Methane for reaction		H2	Coke
	With bio methane	**With CNG**		
Kg/hr	0.38680699	0.386807	0.08749	0.26064
Cost/kg	54.54	90	150	
Total Cost/Hr	21.096453	34.812629	13.1233	******

Total Energy Used		
After heat intergration with feed CH4		
Reactor	0.58	kW
Cost per kWh	15	Rs.
Cost per Hr operation	8.7	Rs



	With bio methane	**With CNG**
Total OPEX/Hr	29.796453	43.512629
Cost Of H2/Hr	13.1233183	13.123318
Expected cost of the formed carbon should be more than	16.6731347	30.38931

- Rs. 130/kg of C without heat integration with CNG
  Rs 116.59/kg of C with heat integration
- Rs 63.97/kg of C with Bio-methane feed
- No cost for catalyst
- No CH4-H2 separation cost considered

1. Biogas in balloon with ~300 ppm H2S – **₹ 18.25/sm3**
2. Biogas after scrubbing to remove H2S (-- ppm H2S) - **₹ 22.3/sm3**
3. Biomethane after removing CO2 - **₹ 35.95/sm3**