Hanzehogeschool Groningen
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Cost minimisation of hydrogen

Case study hydrogen residential area Hoogeveen

A mixed integer linear programming optimisation model was developed to minimise the net present cost of decentralised hydrogen production for heating and mobility demand on neighbourhood urban scale, while adhering to EU targets on greenhouse gas emission savings when implementing renewable fuels.

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Method

Of a selected year, hourly profiles of hydrogen demand (heating, mobility) and supply (PV, wind) were used in an energy system model (Figure 1), in order to minimise the cost of hydrogen for heating and mobility.

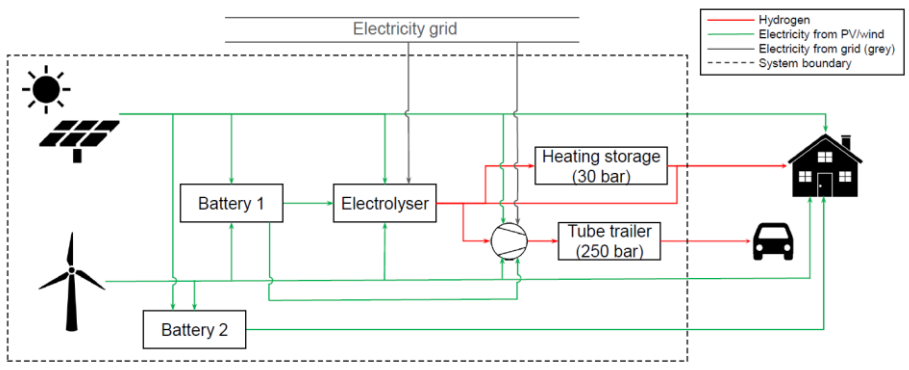

Figure 1: Energy system considered. 'Heating storage' represents hydrogen storage for heating at 30 bar, and 'Tube trailer' represents hydrogen storage for mobility at 250 bar.

Six scenarios were defined concerning the demand: H (heat only), M (mobility only), HM (heat and mobility), HE (heat and electricity), ME (mobility and electricity), HME (heat, mobility and electricity).

Current results

The levelised cost of hydrogen (LCOH) was calculated for the six scenarios (Figure 2). Where applicable LCOH was calculated for heating and for mobility separately. For each scenario, the greenhouse gas emission saving was 70% compared to a fossil fuel reference: natural gas in the case of heating, and gasoline in the case of mobility.

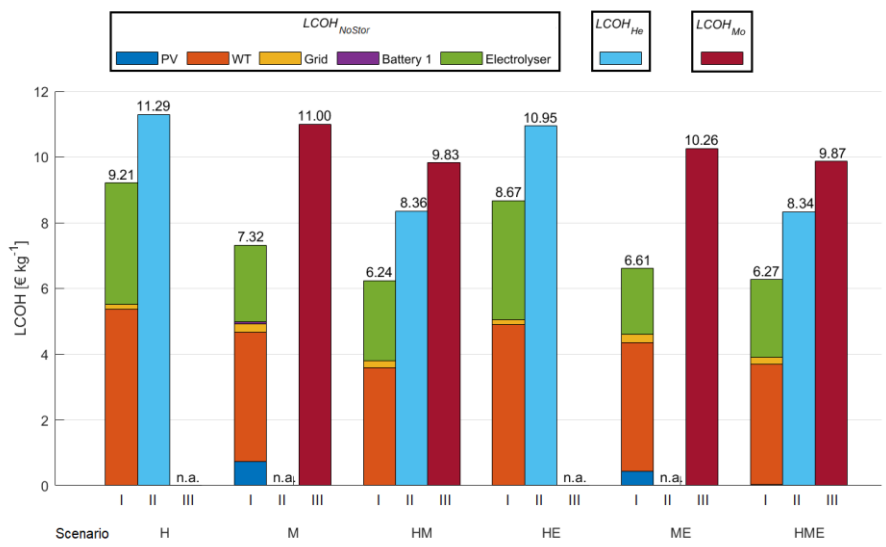

Figure 2: The LCOH calculated for the six scenarios. I: $LCOH_{noStor}$ *[€ kg^{-1}], LCOH up to and including electrolysis but no hydrogen storage included.* II: $LCOH_{He}$ *[€ kg^{-1}], LCOH for heating as delivered from the heating storage, this includes* $LCOH_{noStor}$. III: $LCOH_{Mo}$ *[€ kg^{-1}], LCOH for mobility as delivered from a tube trailer, this includes* $LCOH_{noStor}$.
n.a. = *not applicable.*

Conclusions

- The results support potential cost reductions of combined demand patterns
- A sensitivity analysis showed a strong influence of electrolyser efficiency, wind turbine parameters, and EU target emission reduction on levelised cost
- Wind energy was strongly preferred because of the lower cost and the low GHG emissions, compared to PV and grid electricity.

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