Optimal installation of the distributed H_2 production system with cost and safety considerations

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1. Introduction – H_2 is an important commodity chemical that can also be used as an alternative fuel. The way how H_2 is currently produced and distributed, however, is not compatible with this usage. This is primarily due to the high costs associated with storing and delivering H_2 from the centralized production facilities to the end-use sites like H_2 stations that will be distributed throughout a region [1]. The on-site production of H_2 at the locations where they are being consumed can contribute to lowering the overall cost of delivering H_2 [2]. This study proposes a methodology for modelling and solving the optimization problem of configuring the sizes and layout of H_2 production sites that minimizes the overall cost while meeting the safety requirements. The application of the proposed methodology to a hypothetical case involving H_2 supply to three stations (Image 1) is included.

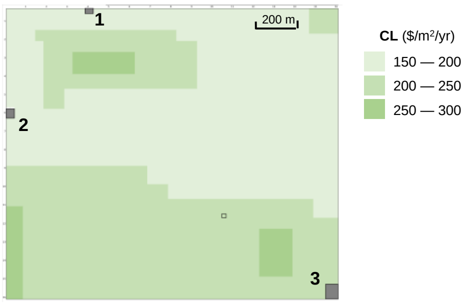

Image 1. The dimensions and locations of H_2 stations inside the hypothetical 2D surface (1600 m x 1600 m)

2. Experimental – A mixed integer non-linear programming (MINLP) model has been developed and applied to the hypothetical case of designing the H_2 production and supply system described in below.

3. Results and Discussion – The hypothetical case involves producing and supply H_2 to 3 nearby fuelling stations shown in Image 1. Techno-econometric parameters for 6 H_2 production technologies were surveyed and adopted in analysing the costs associated with meeting H_2 demand of all stations (Image 2). Aside from the optimal design found by the proposed methodology, central and on-site production systems have been studied for comparison. The total cost for the most optimal solution was about 8,000 US$/day. This translates to 5.5 $/kg-$H_2$, which is still above the target level (< 2.0 $/kg-$H_2$) defined by the US DOE [1]. The sum of fixed and variable cost make up more than 80% of the total cost for all technologies across the three cases; therefore, the DOE target cannot be obtained by only improving the storage and transportation technologies.

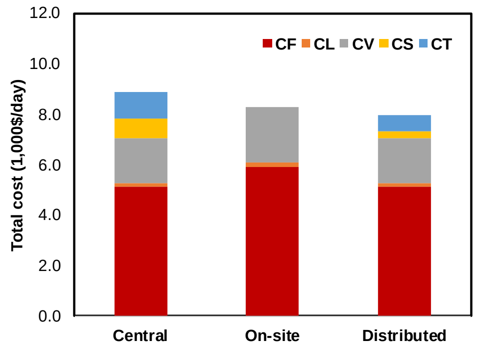

Image 2. the comparison of overall costs between the centralized, on-site, and optimal distributed system

4. Conclusions - The results demonstrate how the optimally distributed layout found by the methodology can reduce the overall cost compared to the traditional centralized production system. We believe that our findings will merit especially those interested in managing production and supply of H_2 energy.

5. References

[1] K. Reddi, A. Elgowainy, N. Rustagi, E. Gupta, *Int. J. Hydro. Energy*, **42**(1), (2017) p. 21855.
[2] Z. Abdmouleh et al., *Renew. Energy*, **113**(1), (2017) p. 266.