

Digital Twin for integrated production and maintenance planning in hydrogen-based process industries

Introduction

Green hydrogen presents a promising solution for decarbonizing energy-intensive process industries like glass, aluminium, and steel. The EU-funded initiative H2GLASS, which supports this research, aims primarily to demonstrate the feasibility of hydrogen adoption in the glass sector. However, transitioning to hydrogen comes with some challenges, including the lack of hydrogen-related infrastructure in manufacturing plants and the need to ensure a continuous and reliable hydrogen supply for industrial furnaces while maintaining safe operations. To facilitate this transition, Digital Twin (DT) technology has been identified as a valuable tool for supporting production and maintenance planning decisions. Given the strong interdependencies between these tasks, an integrated approach to decision-making can enhance overall performance. With its real-time synchronization capabilities and ability to provide a unified view of manufacturing processes, DT has the potential to improve collaborative decision-making, ultimately enabling a more efficient transition to hydrogen-based manufacturing.

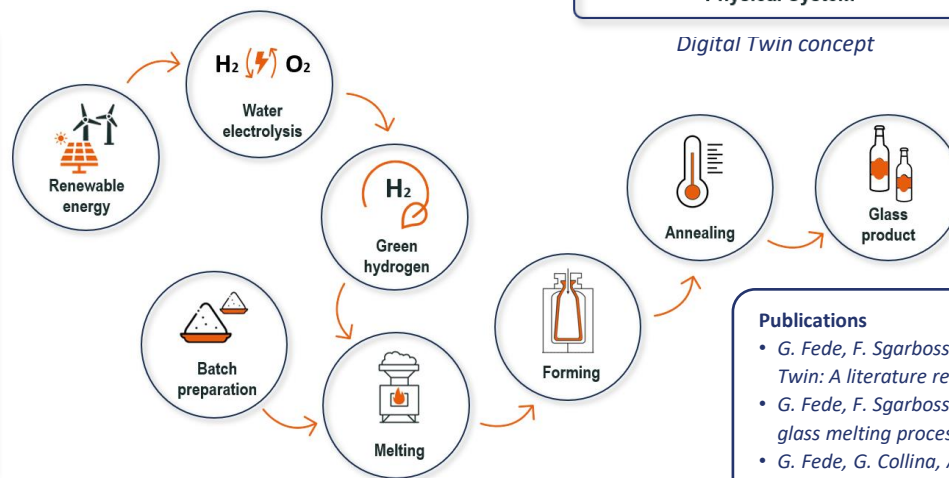
Primary objective

Investigate the benefits of integrating production and maintenance planning using DT in hydrogen-based process industries.

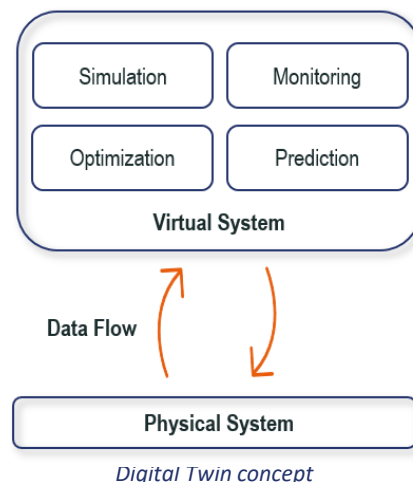
Secondary objectives

With reference to hydrogen-based process industries:

- Develop a multi-objective model for physical system design that considers production and maintenance performance indicators.
- Develop a simulation model to identify key factors influencing production and maintenance planning decisions.
- Develop a DT-based framework for joint production and maintenance planning.



Hydrogen-based glass manufacturing process



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Related projects: H2GLASS - advancing Hydrogen (H₂) technologies and smart production systems TO decarbonise the Glass and Aluminium SectorS

- *PhD candidate at the Department of Mechanical and Industrial Engineering (NTNU)*
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Estimated progress of the PhD project:



Publications

- G. Fede, F. Sgarbossa, N. Paltrinieri. (2024). Integrating production and maintenance planning in process industries using Digital Twin: A literature review. *IFAC-PapersOnLine*, 58 (19), 151-156. <https://doi.org/10.1016/j.ifacol.2024.09.124>
- G. Fede, F. Sgarbossa, D.F. Silva, G. Collina. (2025). A model-based approach to hydrogen supply scenarios for decarbonizing the glass melting process. *Accepted* for 11th IFAC Conference on Manufacturing Modelling, Management and Control (MIM 2025)
- G. Fede, G. Collina, A. Tugnoli, M. Bucelli, D.F. Silva, F. Sgarbossa. (2025). Hydrogen supply scenarios for the decarbonization of energy-intensive process industries considering costs, safety and environmental performance: A multi-objective model-based approach. *To be submitted to Safety Science*.