DC Number	DC1
Title of the PhD Project	Hierarchical Coordinated Operation Control of Integrated Electric-Hydrogen Systems
Keywords	Hydrogen networks, (model) predictive control, optimal operation control
Recruitment organisation	Fraunhofer Research Institution for Energy Infrastructures and Geothermal Systems IEG
Supervisors names and contacts	Johannes Schiffer (johannes.schiffer@ieg.fraunhofer.de) and Anton Plietzsch (anton.plietzsch@ieg.fraunhofer.de)
Scientific context and objectives	Green hydrogen is a cornerstone to successfully master the energy transition and enable the European Green Deal. For this, an intra-European hydrogen network and market needs to be established. Compared to conventional natural gas networks, this endeavour requires novel approaches and solutions. A main reason for this is that hydrogen networks are expected to have multiple, dispersed infeeds, e.g., via large-scale electrozyers distributed across the system. Consequently, there is a strong need for developing suitable control and operation strategies for future cross-national hydrogen networks. This challenge is addressed in the current project. The main objective of the project is to develop a predictive hierarchical control scheme for the coordinated operation of multi-area integrated electric and hydrogen systems. To this end, building upon existing expertise at Fraunhofer IEG, a dynamic model of integrated electric-hydrogen system is to be developed. Then, the optimal combination of economic and physical constraints under uncertainties shall be investigated. A particular emphasize shall be given to the efficient system integration and operation of electrolysers for green hydrogen production and hydrogen-based combined heat and power plants. Finally, the potential of the derived control approach shall be demonstrated on realistic case studies. Fraunhofer IEG is taking a leading role in the development of future hydrogen infrastructure and technologies. The DC will join the Competence Center «Energy Management and Control» and work in close collaboration with several colleagues at Fraunhofer IEG, who are engaged in hydrogen-related projects, such as the TransHyde flagship project or RefLau.
Required skills	• A degree in natural sciences or engineering, preferably with a focus on control engineering, automation engineering, energy and process engineering, optimization methods - alternatively you have a comparable qualification. • Sound knowledge of control engineering or optimization methods or energy technology • Experience in Matlab/Simulink or at least one higher programming language (preferably C++, Python or Julia) • Ability to work scientifically, independence, flexibility, teamwork and communication skills • Interest in applied research work in the fields of control and analysis of complex, intelligent energy systems • Desire for professional and personal development, possibly for a doctorate • Very good knowledge of English and, if possible, German
References	[1] R. van Rossum, J. Jens, G. La Guardia, A. Wang, L. Kühnen, and M. Overgaag, “European hydrogen backbone: A European hydrogen infrastructure vision covering 28 countries,” Guidehouse, Apr, 2022. [2] P. Domschke, B. Hiller, J. Lang, V. Mehrmann, R. Morandin, and C. Tischendorf, “Gas network modeling: An overview,” preprint, 2021. [3] L. Grüne, L and J. Pannek. Nonlinear model predictive control. Springer International Publishing, 2017.

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