POLITECNICO DI MILANO

PhD in CHIMICA INDUSTRIALE E INGEGNERIA CHIMICA / INDUSTRIAL CHEMISTRY AND CHEMICAL ENGINEERING - 40th cycle

PNRR 629 PA Research Field: ADVANCEMENT IN THE LEGISLATION AND TECHNICAL GUIDELINES FOR PRODUCTION, TRANSPORT AND USE OF HYDROGEN AND ITS BLENDS

Monthly net income of PhDscholarship (max 36 months)
€ 1400.0 In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity	
Motivation and objectives of the research in this field	Modern economies focus on reducing GHG emissions to mitigate the effects of climate change. Countries around the world have begun to shift energy production by exploiting more and more renewable energy sources (RES). By 2040, EU RES-based technologies will account for 80% of new installed power, while, after 2030, wind energy is expected to become the main source of electricity. Wind energy, however, has problems associated with the variability of electricity generation, resulting from variable atmospheric conditions. To increase the application of RES, a significant development in energy storage technology is required in the electricity generation sector. Power-to-gas is an example of this technology: electrical energy can be converted into gaseous fuel (hydrogen). Hydrogen, as an energy carrier, can store the greatest quantities of energy and has a high energy content per unit of mass. Hydrogen has great importance as a promising green energy carrier, but it is not available in nature, thus it is usually generated as a secondary energy carrier from primary sources, such as natural gas or wind energy. The EU commission has published regulations concerning hydrogen usage (https://ec.europa.eu/info/news/commission-launches-consultation-regulatory-framework-renewable-hydrogen-2022-may-20_en) and strategic priorities and actions needed concerning hydrogen production in the so-called

	hydrogen valleys (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13875-REPowering-the-EU-with-Hydrogen-Valleys-roadmap-_en) and is presently updating the regulation for the transition to hydrogen of heavy-duty vehicles (https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/14235-Determination-of-CO%E2%82%82-emissions-and-fuel-consumption-for-heavy-duty-vehicles-updated-rules_en). In this framework, and in relation to DM629 criteria for PA PhD programs, the purpose of this research is: 1) to follow the updates of the regulations, laws and CEN/ISO standards concerning hydrogen production, transport, and use (both pure and mixed with other fuels, or as a liquid fuel precursor) with reference to the Italian and the EU legislation. 2) to develop models and measurement methods that may give the necessary information for the development and application of the EU and Italian regulations 3) to give policy guidelines for what concerns the problematics, with particular attention to safety, that may emerge in the application of the regulations as well as in a possible need for their evolution and interpretation
Methods and techniques that will be developed and used to carry out the research	The research program will be developed along three different, parallel and synergic lines, effectively exploiting a multidisciplinary strategy. The first line of research will focus on the update of the legal and voluntary framework of reference for what concerns hydrogen production, transport, and use, with specific reference to the technical instructions of applicative nature. Technical information and a related consistent legislation are necessary to define the level of impurities that are acceptable in a hydrogen blend, both for transportation and for utilization. The present legislation and the existing CEN/ISO standards are thus investigated in this first line of research, by studying existing publications and contacting directly the interested administrative (EU, Italian administration at the local - Comune, Regione - and national level) and industrial (e.g., SNAM, A2A, ...) stakeholders. In the second line of research, some key aspects related

	to hydrogen production, transportation and use that emerge from the analysis of legal framework of reference as of key relevance and that require further investigations will be investigated either at the theoretical level through the development of physical consistent transport models or by direct experimentation, as it is planned to do through the cooperation with ‘Innovhub - SSI’. For example, hydrogen combustion as a pure gas or in a blend with other gases may be investigated in conditions representative of its use in a boiler with the aim of identifying conditions for its safe use, also in light of the existing legislation concerning the limitation of CO2 production. In the third line of research, the hydrogen production, transport and utilization cycle will be investigated from a broader perspective to compare the performance of the different existing technologies, from an economic and sustainability standpoint, with a particular focus on the impact of leakages of hydrogen along the chain, with the intent of giving the necessary information for the development and application of the EU and Italian regulations and policies. This objective will be pursued through fluid dynamics simulations of the transport of hydrogen along the chain as a pure gas, or as a mixture, also in relation to existing technologies.
Educational objectives	Learn both the legal and voluntary (CEN/ISO standards) framework related to hydrogen production, transport and use, both at the national and international level. Learn how to develop models of transport (also through computational fluid dynamics simulations), use and generation of hydrogen and its blends. Learn how to perform experiments related to transport, use and generation of hydrogen and its blends
Job opportunities	Engineering position in the national and international (EU) public administration. Safety and environmental engineer in chemical and energy companies. R&D in chemical and energy companies. Engineering positions in gas companies.

Composition of the research group	4 Full Professors 4 Associated Professors 4 Assistant Professors 15 PhD Students
Name of the research directors	Prof.ssa V. Busini, Prof. C. Cavallotti

Contacts
CFAlab Homepage https://www.cmic.polimi.it/ricerca/elenco-gruppi-di-ricerca/cfalab/

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	700.0 €
By number of months	6

National Operational Program for Research and Innovation	
Company where the candidate will attend the stage (name and brief description)	Innovhub Stazione Sperimentale per i Combustibili, Socio Unico: Camera di commercio di Milano Monza Brianza Lodi Via Galileo Galilei 1, San Donato https://www.innovhub-ssi.it/chi-siamo/le-aree/area-combustibili.kl
By number of months at the company	6
Institution or company where the candidate will spend the period abroad (name and brief description)	To be defined
By number of months abroad	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information

Confidentiality: since this is a thematic scholarship, the management of Confidential Information, Results and their publication is subordinate to the restrictions agreed upon with the funding company.
Upon acceptance of the scholarship, the beneficiary must sign a specific commitment.

Individual budget for research (about 5.700 euro):
1st year: 1.900 euro;
2nd year: 1.900 euro;
3rd year: 1.900 euro

Teaching assistantship (availability of funding in recognition of supporting teaching activities by the PhD student): there are various forms of financial for activities of support to the teaching practice. The PhD student is encouraged to take part in these activities within the limits allowed by the regulation.


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