# Paolo Colbertaldo

## PROFESSIONAL EXPERIENCE

Oct 2020 - present **Assistant Professor Junior (RTD-A)**
*Group of Energy Conversion Systems (GECOS)*
*Department of Energy, Politecnico di Milano · Milan, Italy*
Research topics: hydrogen, Power-to-Gas, electrolysis, fuel cells, $H_2$ carriers, energy storage, energy system scenarios, sector coupling and infrastructure (power, gas, mobility, industry).

Nov 2018 - Oct 2020 **Post-doctoral Research Fellow**
*Group of Energy Conversion Systems (GECOS)*
*Department of Energy, Politecnico di Milano · Milan, Italy*
Research topics: Power-to-Gas, electrochemical hydrogen systems (electrolysis and fuel cell), integrated energy systems and infrastructure (power, gas, mobility, industry), high-RES scenarios.

Nov 2015 - Oct 2018 **Research Fellow (PhD Student)**
*Group of Energy Conversion Systems (GECOS)*
*Department of Energy, Politecnico di Milano · Milan, Italy*
Research area: hydrogen, Power-to-Gas, energy storage, sector integration, scenario analysis.

Jun 2018 - Sep 2018 **Visiting PhD Student**
*Department of Process and System Analysis (VSA) · Institute of Energy and Climate Research - Electrochemical Process Engineering (IEK-3), Forschungszentrum Jülich · Jülich, Germany*
Abroad research period within the PhD programme (Dr. Thomas Grube, Dr. Martin Robinius).
- Techno-economic analysis of hydrogen systems and infrastructure for clean mobility.

May 2017 - Mar 2018 **Visiting Research Scholar**
*National Fuel Cell Research Center, Advanced Power and Energy Program*
*Dept. of Mechanical and Aerospace Engineering, University of California - Irvine · Irvine, CA, USA*
Abroad research period within the PhD programme (Prof. Jack Brouwer).
- Experimental research activities on PEM electrolysis and Power-to-Gas.
- Analysis of Power-to-Gas and energy storage for state-scale energy system integration.

Jul 2014 - Feb 2015 **R&D intern**
*Snam Rete Gas S.p.A. · San Donato Milanese (MI), Italy*
- Master's Thesis development: Dynamic operation of natural gas grid, Quality Tracking, simulation of real pipelines operation using commercial software and developing *ad hoc* models.

## EDUCATION AND TRAINING

2019 **Ph.D. *cum laude* in Energy and Nuclear Science and Technology**
*Politecnico di Milano · Milan, Italy*
- Research field: Clean energy conversion systems
- PhD Thesis: *Power-to-Hydrogen for long-term power and transport sector integration*
- Recipient of *AIMSEA Award for PhD Thesis – 2020 Edition*

2015 **Italian professional qualification as Industrial Engineer (Esame di Stato)**
*Ordine degli Ingegneri della Provincia di Milano & Politecnico di Milano · Milan, Italy*

2015 ASP Diploma for Graduate Courses - IX cycle

*Alta Scuola Politecnica (ASP) – Politecnico di Milano & Politecnico di Torino*

- Multidisciplinary excellence programme, parallel to MSc, enrolment upon selection (150 students per year)
- Topics: Technology, Management, Innovation, Sustainability

2015 Master of Science in Energy Engineering

*Politecnico di Milano · Milan, Italy*

- Master's Thesis: *Analysis and modelling of natural gas transport in the national grid: Quality Tracking*

2015 Master of Science in Energy and Nuclear Engineering

*Politecnico di Torino · Turin, Italy*

- Double degree awarded within the ASP programme

2013-14 MSc international exchange semester - *Energy Technology* programme

*KTH Royal Institute of Technology · Stockholm, Sweden*

- Courses and exams within the *Erasmus* programme

2012 Bachelor's Degree in Energy Engineering

*Politecnico di Milano · Milan, Italy*

- *ASPRI* diploma (research-oriented classes during the three years, merit-based enrolment)

## PROJECTS

EU projects

- **HiPowAR** (H2020, 2020-2024): Highly efficient Power production by green Ammonia total Oxidation in a Membrane Reactor
- **GRASSHOPPER** (H2020, 2018-2021): GRid ASsiSting modular HydrOgen Pem PowER plant
- **DEMCOPEM-2MW** (FP7, 2015-2018): Demonstration of a combined heat and power 2 MWe PEM fuel cell generator and integration into existing chlorine production plant

Italian projects

- **HERMES** (PRIN, 2019-2022): High Efficiency Reversible technologies in fully renewable Multi-Energy Systems

Industrial projects

- 2021-22: Integration of power-to-hydrogen with intermittent RES-based power generation.
- 2021: Assessment of e-fuel production processes and e-fuels potentiality.
- 2019-21: Dynamic simulation of gas grids.
- 2021: Assessment and comparison of large-scale hydrogen storage technologies.
- 2018-21: Innovative intermediate-temperature SOFC systems.
- 2018-19: Techno-economic analysis of hydrogen transport and distribution alternatives.
- Other numerical and experimental activities on hydrogen storage, electrochemical systems (fuel cells and electrolysers), and integration of P2G plants with RES-based power generation plants.
- Funding partners: 2i Rete Gas, Claind, Edison, ENI, Gelsia, Giacomini, InnovHub, Italgen, Pietro Fiorentini, PLT Energia, SNAM, Terna, UNEM.

## DIDACTIC ACTIVITIES

Teaching assistant

Tutorial classes, seminars, and project tutoring within university courses for students enrolled in Engineering programmes (Electrical, Energy, Food, Management, Mechanical, Mobility) at Politecnico di Milano, taught in Italian (IT) or English (EN):

- *Power production from renewable energy* (MSc, IT/EN), A.Y. 2015-16, 2016-17, 2019-20
- *Sistemi energetici* (BSc, IT), A.Y. 2015-16, 2016-17, 2017-18, 2018-19, 2019-20, 2020-21, 2021-22
- *Wind, hydro and geothermal power generation* (MSc, EN), A.Y. 2018-19, 2019-20
- *Sistemi energetici e impatto ambientale* (BSc, IT), A.Y. 2018-19, 2019-20, 2020-21
- *Energy & emissions in transportation systems* (MSc,EN), A.Y. 2018-19, 2019-20, 2020-21, 2021-22
- *Energy systems LM* (MSc, EN), A.Y. 2019-20
- *Sustainable Energy in Food Industry* (MSc, EN), A.Y. 2020-21

Lecturer

Responsible and main lecturer of the course *Hydrogen Technologies* within MSc in Energy Engineering (A.Y. 2021-22)
School of Industrial and Information Engineering, Politecnico di Milano

Post-graduate courses

Lectures in second-level Specializing Courses (post-MSc)

- A.Y. 2017-18: (i) *Natural gas grid* and (ii) *Biogas, biomethane, and P2G* *(Master RIDEF 2.0 - Reinventare l'energia* ·Department of Energy, Politecnico di Milano)
- A.Y. 2019-20: *Power-to-Gas, Hydrogen Infrastructure, and Sector Coupling* (*Master Energy Innovation* · Department of Energy, Politecnico di Milano)
- A.Y. 2020-21: *The natural gas infrastructure: transport and distribution grids, storage. Biogas, biomethane and alternative fuels.* (*Master RIDEF 2.0 - Reinventare l'energia* · Department of Energy, Politecnico di Milano)

## SKILLS AND COMPETENCES

IT tools

- Advanced knowledge of MS Office suite
- Programming languages: advanced MATLAB; good VBA, SQL; basic C, Python, R
- Mathematical optimization: Yalmip, Gurobi, CPLEX, GAMS
- Process simulation: Aspen, Simulink
- CAD software (basic): SolidWorks, Solid Edge, Autodesk Inventor
- Georeferencing GIS: QGIS

## ADDITIONAL INFORMATION

Awards

- *Premio AIMSEA per Tesi di Dottorato - Edizione 2020*
  Awarded by the Italian Association of Fluid Machinery and of Energy Systems and Power Generation (*Associazione Italiana delle Macchine a fluido e dei Sistemi per l'Energia e l'Ambiente,* AIMSEA) to the three best PhD Theses in the fields of Fluid machinery and of Energy systems and power generation.

International conferences

- Session chair "High-temperature Corrosion & Catalysis"
  *8th European Fuel Cell Piero Lunghi Conference - EFC19, Napoli, IT, Dec 2019*
- Session organizer "Energy storage and integration of energy networks"
  *76th ATI National Conference (Italian Thermotechnics Association) - ATI2021, online, Sept 2021*
- Session chair "Smart transport systems and policy"
  *16th Conference on Sustainable Development of Energy, Water and Environment Systems – SDEWES2021, Dubrovnik, HR (hybrid presence-online), Oct 2021*

Peer reviews

- Reviewer of scientific articles for peer-reviewed journals
  ACS Publications: *Energy&Fuels, Omega, Sustainable Chemistry & Engineering;* ASME: *J of Thermal Science and Engineering Applications;* CELL PRESS: *Joule;* ELSEVIER: *Energy*, *International Journal of Hydrogen Energy, Renewable and Sustainable Energy Reviews, Solar Energy;* MDPI: *Energies*, *Sensors, Sustainability*; Springer: *Environmental Science and Pollution Research.*
- Reviewer of conference papers for international conferences
  *International Conference on Applied Energy* ICAE; *ATI National Conference*; *European Fuel Cell Conference* EFC.

Associations

- *Alta Scuola Politecnica Alumni Association* (*ASP Alumni*)
  Association member.
  Board member (terms 2018-19 and 2020-21), responsible of Education activities.
- *American Chemical Society (ACS)*
  Association member.
- *Associazione Idrogeno Italia (H2IT)*
  Involvement in Working Groups (participation and coordination); part of the Scientific Committee.

## LIST OF PUBLICATIONS

### Articles in peer-reviewed journals

E. Crespi, P. Colbertaldo, G. Guandalini, S. Campanari, *Optimal design of hybrid Power-to-Power systems for continuous PV-based energy supply.* Int J Hydrogen Energy, vol. 46, i. 26 (2021), pp. 13691-13708. DOI: 10.1016/j.ijhydene.2020.09.152

P. Colbertaldo, S. Cerniauskas, T. Grube, M. Robinius, D. Stolten, S. Campanari, *Clean mobility infrastructure and sector integration in long-term energy scenarios: The case of Italy*. Renew Sustain Energy Rev, vol. 133 (2020), 110086. DOI: 10.1016/j.rser.2020.110086

P. Colbertaldo, S.B. Agustin, S. Campanari, J. Brouwer, *Impact of hydrogen energy storage on California electric power system: Towards 100% renewable electricity*. Int J Hydrogen Energy, vol. 44 (2019), pp. 9558-9576. DOI: 10.1016/j.ijhydene.2018.11.062

G. Vialetto, M. Noro, P. Colbertaldo, M. Rokni, *Enhancement of energy generation efficiency in industrial facilities by SOFC-SOEC systems with additional hydrogen production*. Int J Hydrogen Energy, vol. 44 (2019), pp. 9608-9620. DOI: 10.1016/j.ijhydene.2018.08.145

P. Colbertaldo, G. Guandalini, S. Campanari, *Modelling the integrated power and transport energy system: The role of power-to-gas and hydrogen in long-term scenarios for Italy.* Energy, vol. 154 (2018), pp. 592-601. DOI: 10.1016/j.energy.2018.04.089

P. Colbertaldo, S.L. Gómez Aláez, S. Campanari, *Zero-dimensional dynamic modeling of PEM electrolyzers.* Energy Procedia, vol. 142 (2017), pp. 1468-1473. DOI: 10.1016/j.egypro.2017.12.594

G. Guandalini, P. Colbertaldo, S. Campanari, *Dynamic modeling of natural gas quality within transport pipelines in presence of hydrogen injections.* Applied Energy, vol. 185 (2017), pp. 1712-1723. DOI: 10.1016/j.apenergy.2016.03.006

G. Guandalini, P. Colbertaldo, S. Campanari, *Dynamic quality tracking of natural gas and hydrogen mixture in a portion of natural gas grid*. Energy Procedia, vol. 75 (2015), pp. 1037-1043. DOI: 10.1016/j.egypro.2015.07.376

### Book sections

S. Campanari, P. Colbertaldo, G. Guandalini, *Renewable power-to-hydrogen systems and sector coupling power-mobility,* in: M. Van De Voorde (Ed.), *Energy, Environment and New Materials. Volume 1: Hydrogen Production and Energy Transition*, De Gruyter, 2021. DOI: 10.1515/9783110596250-018.

S. Campanari, P. Colbertaldo, G. Guandalini, *Power to Hydrogen,* in: U. Desideri, L. Ferrari (Eds.), *Small Scale Energy Generation Handbook*, Elsevier, in press.

### Articles in conference proceedings

F. Parolin, P. Colbertaldo, S. Campanari, Benefits of the multi-modality formulation in hydrogen supply chain modelling, Proceedings of 9th European Fuel Cell and Hydrogen Piero Lunghi Conference (EFC 2021 - Dec 2021), E3S Web Conf, Vol. 334, N. 02003, 2022. DOI: 10.1051/e3sconf/202233402003 .

P. Colbertaldo, E. Bosi, G. Guandalini, *Design and Assessment of a Large-Scale Integrated Power-to-Gas Plant for Renewable SNG Production in Remote Areas*, Proceedings of 16th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2021), Dubrovnik, HR, Oct 2021.

E. Crespi, G. Guandalini, P. Colbertaldo, S. Campanari, *Participation of a PV power plant to the Italian Ancillary Service Market via a hydrogen-based power-to-power system: economic impact of Secondary Frequency Reserve provision*, Proceedings of 16th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2021), Dubrovnik, HR, Oct 2021.

F. Parolin, P. Colbertaldo, S. Campanari, *Design and Optimization of a Multi-Mode Hydrogen Delivery Infrastructure for Clean Mobility*, Proceedings of 16th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2021), Dubrovnik, HR, Oct 2021.

P. Colbertaldo, M. Pugliese, S. Campanari, *Operation of a hydrogen-based multi-energy system using reversible solid oxide cells to supply multiple energy vectors*, Book of Abstracts of 12th International Conference on Hydrogen Production (ICH2P-2021), online, Sept. 2021. ISBN: 978-88-942723-3-8.

P. Colbertaldo, P. Rabbeni, S. Campanari, *Regional modelling of the Italian energy system to assess hydrogen role in long-term scenarios with sector coupling*, Book of Abstracts of 12th International Conference on Hydrogen Production (ICH2P-2021), online, Sept. 2021. ISBN: 978-88-942723-3-8.

A. Cammarata, P. Colbertaldo, S. Campanari, *Simulation of the HiPowAR power generation system for steam-nitrogen expansion after ammonia oxidation in a high-pressure oxygen membrane reactor*, Proceedings of 76th ATI National Conference (ATI 2021 - Sept 2021), E3S Web Conf., Vol. 312, N. 08016, 2021. DOI: 10.1051/e3sconf/202131208016.

P. Colbertaldo, G. Guandalini, S. Campanari, *Development of benchmark scenarios for sector coupling in the Italian national energy system for 100% RES supply to power and mobility*, Proceedings of 76th ATI National Conference (ATI 2021 - Sept 2021), E3S Web Conf., Vol. 312, N. 01003, 2021. DOI: 10.1051/e3sconf/202131201003.

E. Crespi, L. Mammoliti, P. Colbertaldo, P. Silva, G. Guandalini, *Sizing and operation of energy storage by Power-to-Gas and Underwater Compressed Air systems applied to offshore wind power generation*, Proceedings of 76th ATI National Conference (ATI 2021 – Sept 2021), E3S Web Conf., Vol. 312, N. 01007, 2021. DOI: 10.1051/e3sconf/202131201007.

A. Fumarulo, P. Mazza, P. Colbertaldo, D. Bonalumi, M.C. Romano, *Economic analysis of power and CO2-to-methanol systems for the abatement of CO2 emissions from a cement plant*, Proceedings of 15th International Conference on Greenhouse Gas Control Technologies Conference (GHGT-15), Mar. 2021 (exp. Oct 2020, postponed due to covid19). DOI: 10.2139/ssrn.3811442.

P. Colbertaldo, G. Guandalini, E. Crespi, S. Campanari, *Balancing a high-renewables electric grid with hydrogen-fuelled combined cycles: A country scale analysis*, Proceedings of ASME Turbo Expo 2020, vol. 6, Sept 2020 (exp. Jun 2020, postponed due to covid19). DOI: 10.1115/GT2020-15570.

P. Colbertaldo, G. Guandalini, G. Lozza, S. Campanari, *Sizing of integrated solar photovoltaic and electrolysis systems for clean hydrogen production,* Proceedings of 8th European Fuel Cell Piero Lunghi Conference (EFC19), Napoli, IT, Dec 2019. ISBN: 978-88-8286-386-9.

E. Crespi, P. Colbertaldo, G. Guandalini, S. Campanari, *Supply of solar electricity to uninterruptible loads via seasonal storage with Power-to-Power systems,* Proceedings of 8th European Fuel Cell Piero Lunghi Conference (EFC19), Napoli, IT, Dec 2019. ISBN: 978-88-8286-386-9.

P. Colbertaldo, G. Guandalini, S. Campanari, *Hydrogen for High-RES Energy Sector Integration: Comparison of End-Use Pathways*, Proceedings of 14th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2019), Dubrovnik, HR, Oct 2019. ISSN: 1847-7178.

P. Colbertaldo, G. Guandalini, S. Campanari, *The role of hydrogen mobility in fulfilling EU 2050 targets on GHG emissions reduction,* Proceedings of 7th European Fuel Cell Piero Lunghi Conference (EFC17), Napoli, IT, Dec 2017. ISBN: 978-88-8286-356-2.

P. Colbertaldo, G. Guandalini, S. Campanari, *Long-term P2G and hydrogen potential in an integrated energy system: Coupling of power grid and mobility in Italy,* Proceedings of 12th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2017), Dubrovnik, HR, Oct 2017. ISSN: 1847-7178.

P. Colbertaldo, S.L. Gómez Aláez, S. Campanari, *Zero-dimensional dynamic modeling of PEM electrolyzers*, International Conference on Applied Energy ICAE 2017, Cardiff, UK, Aug 2017.

G. Guandalini, P. Colbertaldo, S. Campanari, *Dynamic quality tracking of natural gas and hydrogen mixture in a portion of natural gas grid*, International Conference on Applied Energy ICAE 2015, Abu Dhabi, UAE, Aug 2015.

## Contributions at conferences and workshops (oral presentations)

P. Colbertaldo, E. Bosi, G. Guandalini, *Design and Assessment of a Large-Scale Integrated Power-to-Gas Plant for Renewable SNG Production in Remote Areas*, 16th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2021), Dubrovnik, HR, Oct 2021.

F. Parolin, P. Colbertaldo, S. Campanari, *Design and Optimization of a Multi-Mode Hydrogen Delivery Infrastructure for Clean Mobility*, 16th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2021), Dubrovnik, HR, Oct 2021.

P. Colbertaldo, M. Pugliese, S. Campanari, *Operation of a hydrogen-based multi-energy system using reversible solid oxide cells to supply multiple energy vectors*, 12th International Conference on Hydrogen Production (ICH2P-2021), online, Sept. 2021.

P. Colbertaldo, P. Rabbeni, S. Campanari, *Regional modelling of the Italian energy system to assess hydrogen role in long-term scenarios with sector coupling*, 12th International Conference on Hydrogen Production (ICH2P-2021), online, Sept. 2021.

P. Colbertaldo, G. Guandalini, S. Campanari, *Development of benchmark scenarios for sector coupling in the Italian national energy system for 100% RES supply to power and mobility*, 76th ATI National Conference (ATI2021), online, Sept 2021.

P. Colbertaldo, G. Guandalini, E. Crespi, S. Campanari, *Balancing a high-renewables electric grid with hydrogen-fuelled combined cycles: A country scale analysis*, ASME Turbo Expo 2020, online, Sept 2020 (exp. Jun 2020, postponed due to covid19).

P. Colbertaldo, G. Guandalini, G. Lozza, S. Campanari, *Sizing of integrated solar photovoltaic and electrolysis systems for clean hydrogen production,* 8th European Fuel Cell Piero Lunghi Conference (EFC19), Napoli, IT, Dec 2019.

P. Colbertaldo, G. Guandalini, S. Campanari, *Hydrogen for High-RES Energy Sector Integration: Comparison of End-Use Pathways*, 14th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2019), Dubrovnik, HR, Oct 2019.

P. Colbertaldo, S. Campanari, J. Brouwer, *Power-to-Gas for Microgrids.* International Colloquium on Environmentally Preferred Advanced Generation (ICEPAG 2018), Irvine, CA, USA, Mar 2018.

L. Mastropasqua, G. Guandalini, P. Colbertaldo, S. Campanari, M*odelling rSOC Coupled with Na-based Heat Pipes for Electrochemical Energy Storage Applications.* Fuel Cell Seminar & Energy Exposition, Long Beach, CA, USA, Nov 2017.

G. Guandalini, L. Mastropasqua, P. Colbertaldo, S. Campanari, *Modeling of Power-to-Gas and electric energy storage system based on solar-assisted reversible solid oxide cell (rSOC).* Fuel Cell Seminar & Energy Exposition, Long Beach, CA, USA, Nov 2017.

P. Colbertaldo, G. Guandalini, S. Campanari, *Long-term P2G and hydrogen potential in an integrated energy system: Coupling of power grid and mobility in Italy,* 12th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES2017), Dubrovnik, HR, Oct 2017.

P. Colbertaldo, G. Guandalini, S. Campanari, *Effects of mobility sector evolution on the power grid and long-term P2G hydrogen potential in Italy: A preliminary analysis.* H2FC SUPERGEN 2016 Researcher Conference, Belfast, UK, Dec 2016.

*Autorizzo il trattamento dei miei dati personali ai sensi dell'art. 13 del D. Lgs. 196/2003 del 30 giugno 2003 (Codice in materia di protezione dei dati personali) e dell'art. 13 del GDPR 679/2016 del 27 aprile 2016 (Regolamento Europeo relativo alla protezione delle persone fisiche per quanto riguarda il trattamento dei dati personali).*