Finanziato dall'Unione europea NextGenerationEU | Ministero dell'Università e della Ricerca | Italiadomani Piano Nazionale di Ripresa e Resilienza | NEST Network for Energy Sustainable Transition

ALLEGATO B

PE00000021
"PNRR MUR - M4C2 – NEST - Extended Partnership Network 4 Energy Sustainable Transition"

SPOKE N. 4

CUP D33C22001330002

Research proposal

Innovation for green hydrogen production from biomass

OSMOSYS – Optimization of small-scale oxy-steam gasification and catalytic water-gas shift for renewable hydrogen production

Free University of Bozen-Bolzano
Name of the Principal Investigators (PIs): Prof. Marco Baratieri, Prof. Francesco Patuzzi
Proposal duration in months: 12

Name and qualification of the Principal Investigator (PI): Prof. Marco Baratieri
Name and qualification of the co- Principal Investigator (PI): Prof. Francesco Patuzzi
Name and qualification of the components the research team:

ROLE IN THE PROJECT	*NAME*	*SURNAME*	*INSTITUTION/ DEPARTMENT*	*QUALIFICATION*	*YOUNG (under 40 al 31.12.2023)*	*F/M*
Principal Investigator	*Marco*	*Baratieri*	*Bioenergy & Biofuels LAB, Free University of Bozen-Bolzano*	*Full Professor*	*No*	*M*
co-Principal Investigator (PI)	*Francesco*	*Patuzzi*	*Bioenergy & Biofuels LAB, Free University of Bozen-Bolzano*	*Associate Professor*	*Yes*	*M*

ABSTRACT
Biomass gasification has been identified by the literature as one of the most promising renewable hydrogen production pathways. However, especially at the small scale, the industrial-scale implementation of biomass-to-hydrogen systems is hindered by the complexity of multistage processes required for syngas cleaning. Such cleaning operations are required, among others, upstream of water-gas shift reaction trains, a process step necessary to increase the inherently low hydrogen yields delivered by biomass stoichiometry. The project aims to address the current limitations related to biomass-to-hydrogen at the small scale by assessing experimentally a coupled system comprising novel oxygen-steam gasification of residual biomass and catalytic water-gas shift technology. The specific objectives of the proposed experimental work include 1) optimizing the operational parameters (oxygen and steam flow rates) of fixed bed oxygen-steam gasification for maximal hydrogen yield, 2) determining the degree of contamination of the obtained syngas with sulphur compounds that jeopardize the performance of downstream water-gas shift catalysts and 3) testing a water-gas shift fixed-bed bench-scale reactor loaded with selected commercial catalyst and fed with artificial syngas reproducing oxygen-steam syngas. At the project onset a review of water-gas shift state of the art will be conducted alongside industrial consultations to identify the most promising innovations and commercial catalyst technologies available, leading to the selection of the catalyst to be tested in the project. The results of the experimental activity will enable determining the expected hydrogen yield on biomass attainable with a coupled process. Moreover, syngas composition results and contaminants tolerance specifications provided by catalyst manufacturers will be used to define a conceptual syngas cleaning process adequate for small-scale biomass-to-hydrogen.

RESEARCH PROPOSAL

Section a. State-of-the-art and objectives

Biomass gasification has been identified as one of the most promising renewable hydrogen production technologies by several authors in the scientific literature. Reasons for such consideration include satisfactory efficiencies, relatively high yields, and low projected costs on the large scale [1–3], as well as the renewability and global availability of lignocellulosic biomass, often accessible at low costs [4,5].

Due to the composition of lignocellulosic biomass and gasifying agents, it is not possible to generate a syngas containing pure hydrogen in the gasification step itself. Therefore, any biomass-to-hydrogen process involving biomass gasification necessarily entails 1) a gasification step, and 2) a set of reforming, separation,

and purification processes. The final application of the purified hydrogen stream determines the degree of purity required in the product and it thus determines the type and intensity of cleaning processes needed. As displayed in Fig. 1, a fundamental structure for a biomass-to-hydrogen process comprises biomass gasification, intermediate tar cracking and/or tar reforming systems, if needed due to excessive tar concentrations in the syngas, a water-gas shift (WGS) reactions train, a carbon dioxide removal system and a final purification step, typically carried out through pressure swing adsorption (PSA) technology, followed by product gas compression and storage. Additional steps may include desulphurization, typically performed via catalytic hydrogenation, catalytic conversion to FeS or ZnS, or via physical or chemical absorption (scrubbing) combined with carbon dioxide absorption.

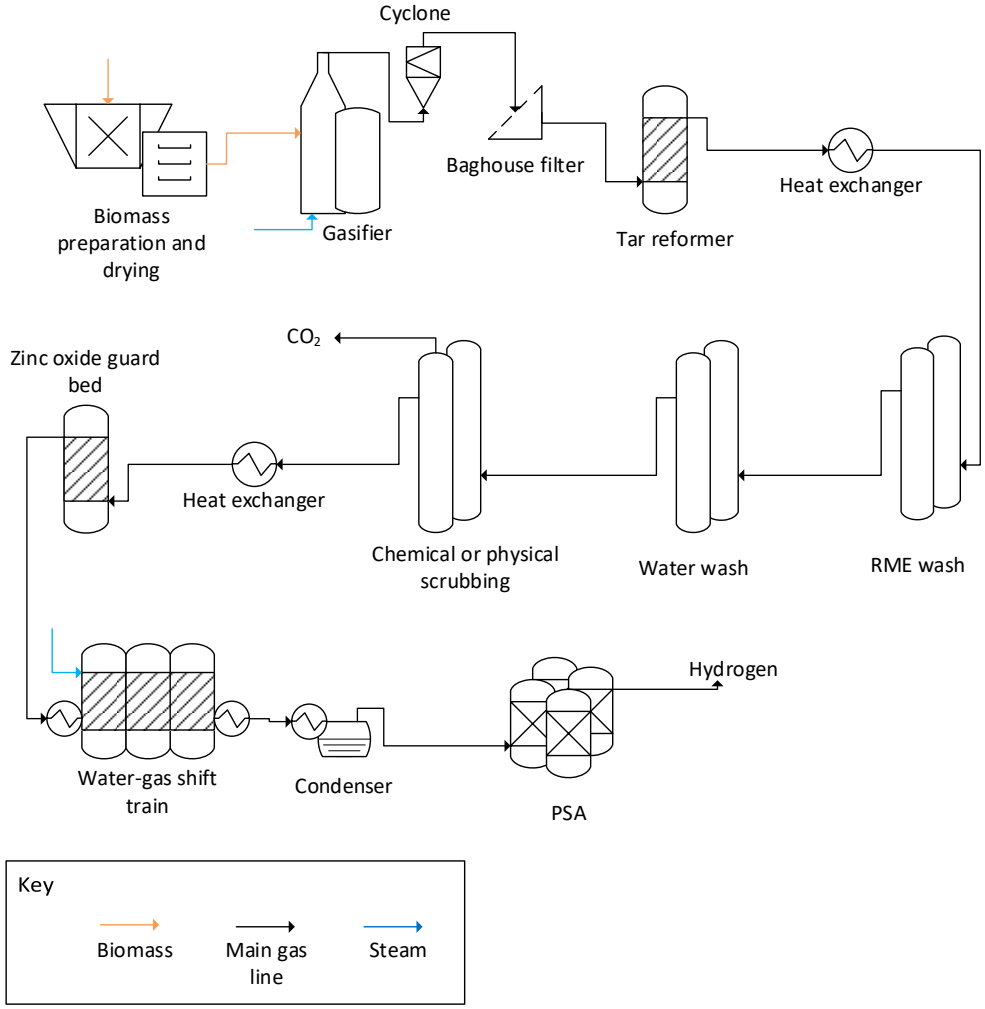

Fig. 1. Schematic diagram of an integrated biomass gasification, syngas reforming and hydrogen separation process.

Within the process anatomy described the role of WGS emerges as crucial in the optimization of hydrogen production from biomass, as it is the step dedicated to increasing the inherently low hydrogen yields embedded in biomass stoichiometry. Any cost-effective, scalable biomass-to-hydrogen process therefore requires an optimization of the interactions between gasification and WGS, which primarily entails 1) the minimization of WGS catalyst contamination risk via deactivation or poisoning, and 2) the optimization of the feed conditions, especially in terms of steam-to-carbon ratios and operating temperatures and pressures. WGS reaction performance and its impact on TOTEX and plant operating hours is especially related to the risk of catalyst deactivation by sulfur (present as H_2S and/or COS in syngas) and other forms of

contamination. The intensive removal of sulfur is typically foreseen in large-scale processes where WGS steps are present. At the small scale, though, the removal of sulfur needs to be optimized through a minimum number of steps, as multi-stage subprocesses and overall process complexity represent aggravating cost factors. While the development of more sulfur-tolerant catalysts has been investigated in the literature in the past, the notion of a residual need for precautionary sulfur removal from syngas has endured as part of process design considerations [6]. Because biomass-to-hydrogen is necessarily related to finite pools of raw resources that require reconciling plant sizes and feedstock availability, the development of cost-effective processes also applicable to the small scale is paramount. In the context of process development, this translates into the need to evaluate in detail the capability of novel gasification technologies of delivering high syngas qualities and low sulfur impurities concentrations to minimize impacts deriving from such contamination on the performance of WGS catalysts, and thus to minimize the need for intensive gas cleanups at the small scale.

Fixed-bed oxygen-steam gasification has been reported as a technology capable of delivering syngas with minimal nitrogen content and low tar content [7], and it is of interest for the development of small-scale biomass conversion processes, as it could enable the treatment of lower quality residual biomass sources already with limited operational complexities but high syngas qualities. This goes along with the ability of WGS to be run at moderate pressures (< 30 bar [8]), thus making use of more affordable conventional steel equipment, typically available with pressure ratings up to 30 bar.

In the present project, we propose an experimental assessment of 1) an innovative oxygen-steam gasification concept and 2) a bench-scale syngas WGS process operating on commercial catalyst to evaluate the performance of each step. In specific, we propose the testing of these two fundamental process steps in two separate stages, where gasification operation is first optimized to maximize hydrogen yields, and commercial WGS catalysis run on artificial syngas is operated to evaluate its CO conversion rates at low or moderate pressures.

By focusing on process fundamentals, the aim of the study is to evaluate the potential for oxygen-steam gasification and WGS as two key process steps capable of delivering satisfactory hydrogen yields already at the small scale.

The specific objectives include to 1) review existing and emerging WGS technologies that allow minimizing upstream syngas cleaning via literature review and consultations with industrial experts; 2) operate a pilot-scale oxygen-steam (oxy-steam) fixed-bed gasifier and optimize its hydrogen yield on biomass; 3) quantify the sulfur content obtained from the oxy-steam gasification of residual biomass under optimal hydrogen-yielding conditions; 4) operate a bench-scale WGS reactor loaded with commercial catalyst and assess CO conversion rates at different steam-to-carbon ratios; 5) determine the theoretical hydrogen yield achievable by a coupled oxy-steam gasification - WGS process based on the experimental results obtained; 6) estimate the minimum syngas cleaning requirements needed to meet acceptable WGS conversion rates based on the experimental findings on syngas quality.

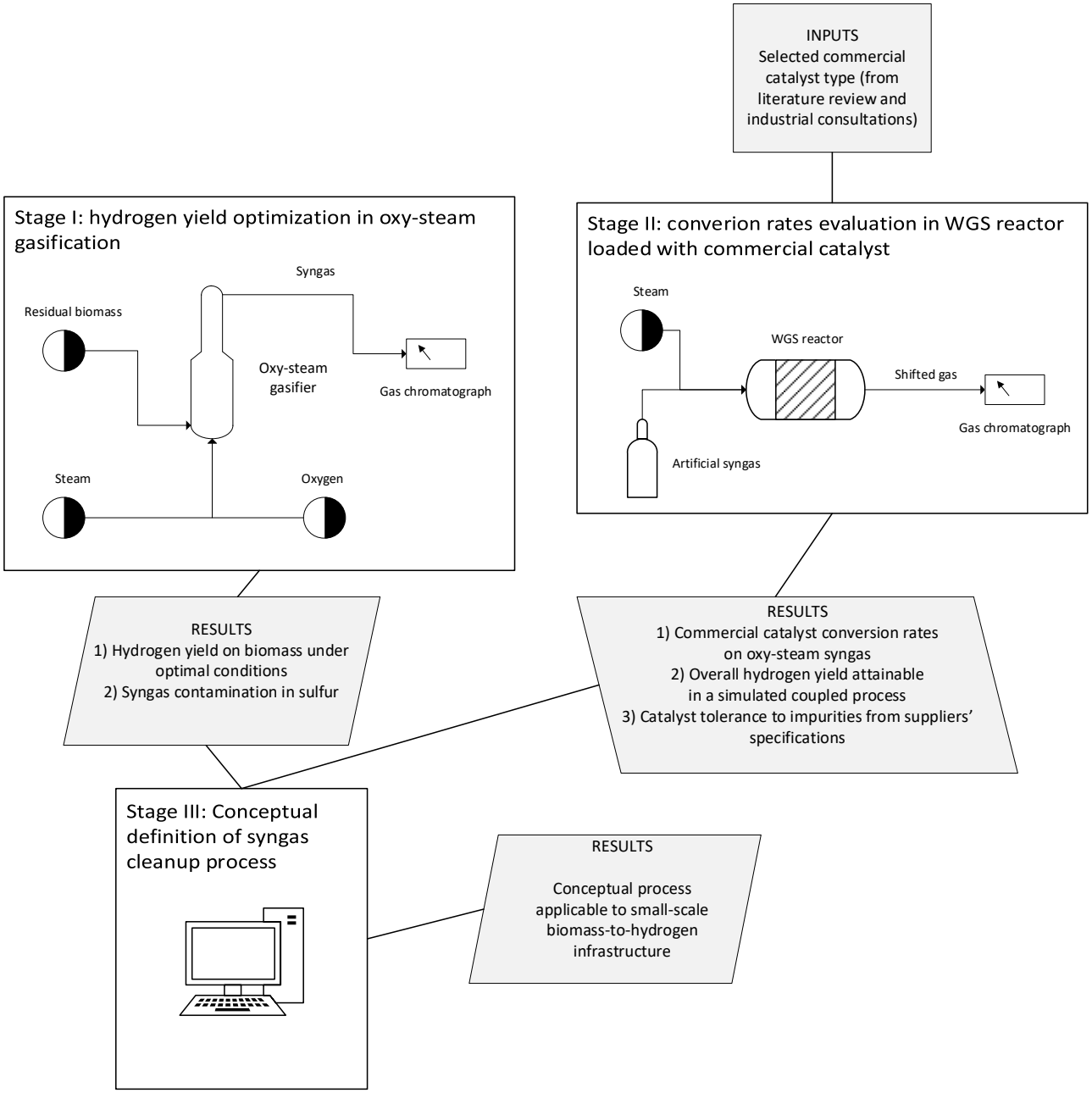

Fig. 2. Schematic of the proposed concept.

Section b. Methodology

The proposed methodology will involve four main steps, articulated as follows.

1. **Literature review and industrial consultations on the state of the art of renewable syngas WGS processing**

A review of the scientific literature based on dedicated databases (e.g., Scopus, Google Scholar, ResearchGate) will be conducted to source the most updated documents (including reviews, experimental and/or modelling assessments) relative to innovations in the field of WGS catalysis for bio-derived syngas. Such review will be combined with consultations with representative industrial experts, thanks to the support of external industrial partners. The review and the consultations will enable identifying the state of the art of WGS catalytic

processes applied to biogenic syngas and guide the subsequent definition of the experimental setup and the selection of the most appropriate commercial catalyst.

2. **Pilot-scale oxygen-steam gasification experimental optimization**

A fixed-bed lab-scale gasifier developed by external contractors will be hosted at the Bioenergy & Biofuels Lab facilities and will be tested with residual biomass woodchips under a set of operating parameters (steam and oxygen flow rates), selecting the operating conditions that yield the highest hydrogen mass yield on dry biomass input. The syngas produced will be characterized in terms of main gas species composition and sulphur contamination through gas chromatography (GC). The pilot experimental setup will have the characteristics displayed in the conceptual diagram presented in Fig. 2.

3. **Experimental assessment of syngas WGS performance**

In a subsequent phase, a bench-scale fixed-bed reactor loaded with a selected commercial catalyst will be tested using an artificial syngas stream reproducing the optimal syngas composition attainable in oxy-steam gasification based on previous literature results and based on the compositions obtained during the above experimental optimization. The WGS unit will be operated at the temperature and pressure conditions specified by the catalyst suppliers and by the literature and as limited by the constraints of safe laboratory operation as well as by the techno-economic limit of 30 bar. Different feed steam-to-carbon ratios will be tested. While the inlet syngas composition will be known, the products obtained at the outlet of the WGS unit will be monitored via GC, thus determining the reaction conversion rates.

4. **Desk assessment of the expected gas cleaning requirements**

The experimental data collected will enable determining the theoretical total hydrogen yield on dry biomass attainable by a coupled oxy-steam gasification – syngas WGS system, under the assumption that the gas stream can be sufficiently cleaned to avert catalyst deactivation. Based on the suppliers' indication on the maximum syngas sulphur content allowed to maintain acceptable catalyst conversion rates, the final part of the study will involve the conceptual definition of the required syngas cleaning process applicable to a small-scale oxy-steam gasifier, which will serve as a basis for future possible process modelling, simulation, and assessment work.

Section c. Available instrumentations and resources

The instrumentation already available at the Bioenergy & Biofuels Lab includes:

a. Equipment for gas analysis including multiple mobile gas chromatographs.
b. Other analytical items including an HPLC, a GC-MS, a BET analyzer, an elemental analyzer and others.
c. Hooded bench and open floor spaces for the testing of both bench, lab, and pilot scale equipment.

Section d. GANTT diagram

Task	Quarter			
	M1-M3	M4-M6	M7-M9	M10-M12
State of the art review and consultation with industry				
Experimental optimization of H_2 yields in oxy-steam gasification				
WGS experimental operation				
Definition of required syngas cleaning process layout				

Section e. Milestones, Deliverables and KPI

Month	Milestone	Deliverable	KPI
M3	Literature review and industrial consultations completed	Report on findings (WGS catalyst types)	At least three suppliers involved, at least ten scientific papers reviewed
M4	Oxy-steam gasification pilot setup installation at the Bioenergy & Biofuels Lab completed	Pilot plant installed	-
M6	Oxy-steam optimization experiments completed	Report on experimental results	Nine operating conditions tested (i.e., three steam flow rate points and three oxygen flow rate points)
M7	WGS setup installation at the Bioenergy & Biofuels Lab completed	Bench system installed	-
M9	WGS experiments completed	Report on experimental results	Nine operating conditions tested (i.e., three syngas flow rates, three temperature points, and three pressure points)
M12	Conceptual syngas cleaning system defined	Report including process flow diagram	-

References

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[2] Nikolaidis P, Poullikkas A. A comparative overview of hydrogen production processes. Renew Sustain Energy Rev 2017;67:597–611. https://doi.org/10.1016/j.rser.2016.09.044.

[3] Cao L, Yu IKM, Xiong X, Tsang DCW, Zhang S, Clark JH, et al. Biorenewable hydrogen production through biomass gasification: A review and future prospects. Environ Res 2020;186:109547. https://doi.org/10.1016/j.envres.2020.109547.

[4] Balat M, Balat M. Political, economic and environmental impacts of biomass-based hydrogen. Int J Hydrogen Energy 2009;34:3589–603. https://doi.org/10.1016/j.ijhydene.2009.02.067.

[5] Balat H, Kırtay E, Kirtay E. Hydrogen from biomass - Present scenario and future prospects. Int J Hydrogen Energy 2010;35:7416–26. https://doi.org/10.1016/j.ijhydene.2010.04.137.

[6] Hulteberg C. Sulphur-tolerant catalysts in small-scale hydrogen production, a review. Int J Hydrogen Energy 2012;37:3978–92. https://doi.org/10.1016/j.ijhydene.2011.12.001.

[7] Singh A, Gupta A, Rakesh N., Shivapuji AM, Dasappa S. Syngas generation for methanol synthesis: oxy-steam gasification route using agro-residue as fuel. Biomass Convers Biorefinery 2022;12:1803–18. https://doi.org/10.1007/s13399-021-02128-y.

[8] Platon A, Wang Y. Water-Gas Shift Technologies. Hydrog. Syngas Prod. Purif. Technol., John Wiley & Sons, Ltd; 2009, p. 311–28. https://doi.org/10.1002/9780470561256.ch6.

Annexes: Curriculum vitae research team

Curriculum vitae PI

PERSONAL INFORMATION

BARATIERI MARCO:

Researcher unique identifier (ORCID 0000-0002-0706-6577)

Date of birth:

URL for web site: https://www.unibz.it/it/faculties/engineering/academic-staff/person/27442-marco-baratieri
https://bnb.groups.unibz.it/

- **EDUCATION**

2007	PhD in Environmental Engineering Department of Civil and Environmental Engineering / University of Trento / Italy Supervisor: Prof. ing. Paolo Baggio
2001	Master in Environmental Engineering Department of Civil and Environmental Engineering / University of Trento / Italy

- **CURRENT POSITION(S)**

2019 – now	Full professor in Thermal Engineering and Industrial Energy Systems (ING-IND/10) Faculty of Engineering / Free University of Bolzano / Italy

- **PREVIOUS POSITIONS**

2015 – 2019	Associate professor in Thermal Engineering and Industrial Energy Systems (ING-IND/10) Faculty of Science and Technology / Free University of Bolzano / Italy
2009 – 2014	Assistant professor in Building Physics (ING-IND/11) Faculty of Science and Technology / Free University of Bolzano / Italy

- **SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS**

2009 – 2024	more than 20 Postdocs / more than 20 PhD / more than 40 Master Students Faculty of / Science and Technology / Engineering / Free University of Bolzano / Italy

- **ORGANISATION OF SCIENTIFIC MEETINGS (if applicable)**

2020	Workshop "Biochar: filiera e prospettive in Alto Adige" nell'ambito del progetto WOOD-UP (FESR), in collaborazione con il Centro Sperimentale Laimburg e il NOI Techpark, Bolzano
2016	Chairman and member of the scientific committe of the international conference "Micro cogeneration through biomass gasification - µCHP16", Bolzano
2014	Member of the Organizing Committee of ESNA2014 conference, Bolzano

- **INSTITUTIONAL RESPONSIBILITIES (if applicable)**

2017 – now	Director of the Master in Energy Engineering (LM-30, joint program with U. of Trento) Faculty of / Science and Technology / Engineering / Free University of Bolzano / Italy
2014 – now	Coordinator of the Research Area in Energy Resources and Energy Efficiency Faculty of / Science and Technology / Engineering / Free University of Bolzano / Italy
2014 – now	Responsible of the "Bioenergy and Biofuels Lab" Faculty of / Science and Technology / Engineering / Free University of Bolzano / Italy
2018 – 2023	Director of the Professional Bachelor in Wood Engineering (L-9) Faculty of / Science and Technology / Engineering / Free University of Bolzano / Italy
2020 – now	Local coordinator of the Erasmus Mundus Joint Master ME3+ in Management and Engineering of Environment and Energy Faculty of / Science and Technology / Engineering / Free University of Bolzano / Italy
2017 – now	Director of the Master in Energy Engineering (LM-30, joint program with University of Trento) Faculty of / Science and Technology / Engineering / Free University of Bolzano / Italy

- **REVIEWING ACTIVITIES (if applicable)**

2022 – now	Panel Member for the panel PE8–Products and Processes Engineering in the evaluation of Consolidator Grants 2022 ERC, European Research Council
2019 – now	Member of Editorial Board, Biomass & Bioenergy International Journal (Elsevier)
2021 – now	Member of Editorial Board, Biomass Conversion and Biorefinery (Springer)
2012 – 2017	Member of Editorial Board, International Journal of Oil, Gas and Coal Technology
2011 – now	Member of scientific committee and topic organizer, European Biomass Conference and Exhibition (EUBCE)
2012 – now	Member of scientific committee and topical chair, Wasteeng Conference
2017 – now	Member of scientific committee, Central European Biomass Conference CEBC
2018 – now	Member of scientific committee, International Conference on Sustainable Solid Waste Management

- **MEMBERSHIPS OF SCIENTIFIC SOCIETIES**

2011 – now	Member, IBPSA, International Building Performance Simulation Association, Chapter Italy
200? – now	Member, FTI, Associazione Italiana della Fisica Tecnica

- **MAJOR COLLABORATIONS**

The City College of New York (CCNY, USA), Prof. Marco Castaldi
Bioenergy 2020+ | BEST, Wieselburg and Graz (Austria)
Ecole des Mines Albi-Carmaux (France), Prof. Ange Nzihou
KIT, Karlsruher Institut für Technologie (Germany), Prof. Reinhard RAUCH
DTU (Denmark), Prof. Ioannis SKIADAS, prof. Irini Angelidaki
The IMT Atlantique (France): Prof. Claire GERENTE & Prof. Audrey VILLOT
Cornell University, Ithaca (USA), Prof. Jillian GOLDFARB

Hiroshima University (Japan), Prof. Yukihiko MATSUMURA
University of the Aegean (Greece), Dr. Stergios VAKALIS
University of Trento, Prof. Luca Fiori
University of Trento, Prof. Maurizio Grigiante
University of Trento, Prof. Rosa Di Maggio

Appendix: All current grants and on-going and submitted grant applications <u>of the PI</u> <u>and Co PI</u> (Funding ID)

<u>Mandatory information</u> (does not count towards page limits)

Current grants (Please indicate "No funding" when applicable):

Project Title	*Funding source*	*Amount (Euros)*	*Period*	*Role of the PI*	*Relation to current proposal*
CARNOT - Decarbonized and CirculAR hydrogeN prOducTion through biomass and waste gasification	Italian Ministry for Education and Scientific Research, MUR (PRIN 2022)	76 266	28/09/2023 - 27/09/2025	**unibz unit responsible** [PI: Unige, Italy]	Green hydrogen generation from biomass gasification
FRONTSH1P - A FRONTrunner approach to Systemic circular, Holistic & Inclusive solutions for a new Paradigm of territorial circular economy	European Commission, Horizon 2020 Framework Programme (Green Deal)	599 560 (16 118 418 whole consortium)	01/11/2021 – 30/09/2024	**unibz unit responsible** [PI: K-FLEX, Poland]	Gasification of waste wood and production of charcoal for multiple utilizations
Alps4GreenC - Implementation pathways for sustainable Green Carbon production in the Alpine Region	European Commission, Interreg Alpine Space Programme	119 350 (740 866 whole consortium)	01/09/2022 - 29/02/2024	**unibz unit responsible** [PI: CCIS, Slovenia]	Gasification of agri-food residues and production of biochar

RFD - Recupero di nutrienti dal processo HTC	European Regional Development Fund of the European Union and Autonomous Province of Bozen-Bolzano (ERDF 2021-2027)	173 842 (551 733 whole consortium)	01/09/2023 - 30/08/2025	**unibz unit co-responsible** [PI: HBI, Italy; unibz unit responsible: Francesco Patuzzi]	Gasification of hydrochar from HTC
CDV - CompostDivino	European Regional Development Fund of the European Union and Autonomous Province of Bozen-Bolzano (ERDF 2021-2027)	154 510 (681 853 whole consortium)	03/01/2024 - 31/12/2026	**unibz unit responsible** [PI: Biologik srl, Italy]	Reuse of agricultural residues for heat production
SustainHEAT - Sustainable heating systems for decarbonizing buildings	European Regional Development Fund of the European Union and Autonomous Province of Bozen-Bolzano (ERDF 2021-2027)	318 179 (1 120 008 whole consortium)	01/10/2023 - 01/10/2026	**unibz unit co-responsible [PI: Eurac Research, Italy; unibz unit responsible: Massimiliano Renzi]**	Development of infrastructure for advanced combustion measurements of syngas and renewable gas

Curriculum vitae CO-PI

PERSONAL INFORMATION

Family name, First name: Patuzzi Francesco
Researcher unique identifier(s): https://orcid.org/0000-0002-9573-6947
Date of birth:

URL for web site: https://www.unibz.it/it/faculties/engineering/academic-staff/person/30127-francesco-patuzzi

- **EDUCATION**

2010-2013 **PhD**
Free University of Bozen/Bolzano, Faculty of Science and Technology, Italy
PhD in Management of Mountain Environment (thesis title: "Modeling and experimental characterization of biomass thermal treatment: torrefaction and pyrolysis applied to wetland and grass biomasses", supervisor: prof. Marco Baratieri)

2007-2010 **Master**
University of Trento, Department of Civil and Environmental Engineering
MSc in Environmental Engineering (thesis title: "Sviluppo di un modello cinetico multifase per l'analisi del processo di torrefazione di biomasse legnose")

2003-2007 **Bachelor**
University of Trento, Department of Civil and Environmental Engineering
BSc in Environmental Engineering (thesis title: "Analisi critica dello stato dell'arte degli impianti di gassificazione di biomassa a piccola scala")

- **CURRENT POSITION(S)**

03.23 – now Associate Professor in Thermal engineering and industrial energy systems (ING-IND/10)
Free University of Bozen/Bolzano, Faculty of Engineering, Italy
- *Teaching BSc courses:* Engineering energetics (L9)
- *Teaching MSc courses*: Thermomechanical measurements (LM33); Computational Thermo-Fluid-Dynamics (LM33)
- *Research*: thermochemical conversion processes applied to biomass, residues and wastes; renewable gas; syngas upgrading routes; thermodynamic and kinetic process modelling

- **PREVIOUS POSITIONS**

08.22 – 03.23 Associate Professor in Thermal engineering and industrial energy systems (ING-IND/10)
Free University of Bozen/Bolzano, Faculty of Science and Technology, Italy

10.19 – 09.22 Researcher on a Fixed-Term Contract (RTDb, ex art. 24 L. 240/2010) in Thermal engineering and industrial energy systems (ING-IND/10)
Free University of Bozen/Bolzano, Faculty of Science and Technology, Italy

02.16 – 09.19 Researcher on a Fixed-Term Contract (RTDa, ex art. 24 L. 240/2010) in Thermal

engineering and industrial energy systems (ING-IND/10)
Free University of Bozen/Bolzano, Faculty of Science and Technology, Italy

01.14 – 01.16 Postdoctoral Research Fellow in Thermal engineering and industrial energy systems (ING-IND/10)
Free University of Bozen/Bolzano, Faculty of Science and Technology, Italy

- **FELLOWSHIPS AND AWARDS**

2021 Research Award 2021 from the Stiftung Südtiroler Sparkasse to the Free University of Bozen-Bolzano presented to Francesco Patuzzi, Faculty of Science and Technology. With this Research Award, the Free University of Bozen-Bolzano honours outstanding scientific achievements carried out in 2020

- **SUPERVISION OF GRADUATE STUDENTS AND POSTDOCTORAL FELLOWS**

2019 – now Supervisor of 1 Postdoc, 1 PhD, 1 Master and 3 Bachelor Students
Free University of Bozen/Bolzano, Faculty of Science and Technology (Faculty of Engineering since 03.2023), Italy

2013 – now Co-supervisor of 13 PhD, 10 Master Student and 3 Bachelor Students
Free University of Bozen/Bolzano, Faculty of Science and Technology (Faculty of Engineering since 03.2023), Italy

- **ORGANISATION OF SCIENTIFIC MEETINGS (if applicable)**

2024 Member of the Scientific committee as Topic Organizer of the 32nd European Biomass Conference & Exhibition (EUBCE2024) that will be held from June 24th to June 27th in Marseille, France

2022 Member of the Awards Committee of the 9th International Conference on Engineering for Waste and Biomass Valorisation (WasteEng2022), held from June 27th to June 30th 2022 in Copenhagen, Denmark.
Member of the Organizing Committee and of the Students Tutoring Scientific Committee of the international conference Building Simulation Applications - BSA 2022, that has been held at the Free University of Bozen-Bolzano from June 29th to July 1st 2022.

2021 Member of the Awards Committee of the 8th International Conference on Engineering for Waste and Biomass Valorisation (WasteEng2020), held from May 31st to June 4th 2021 in virtual mode.

2019 Member of the Organizing Committee of the "EU-Japan biomass seminar" hosted by the 27th European Biomass Conference & Exhibition on May 27th 2019 in Lisbon, Portugal
Member of the Organizing Committee of the "Biomass Study Tour in South Tyrol", held on May 23rd and 24th in South Tyrol in the frame of the "EU-Japan biomass seminar" hosted by the 27th European Biomass Conference & Exhibition on May 27th 2019 in Lisbon, Portugal
Member of the Local Organizing Committee of the 16th IBPSA International Conference and Exhibition - BS 2019, held in Rome from September 2nd to 4th 2019.
Member of the Organizing Committee and of the Students Tutoring Scientific Committee of the international conference Building Simulation Applications - BSA 2019, held at the Free University of Bozen-Bolzano from June 19th to 21st 2019.

2017 Member of the Organizing Committee and of the Students Tutoring Scientific Committee of the international conference Building Simulation Applications - BSA 2017, held at the Free University of Bozen-Bolzano from February 8th to 10th 2017.

2016 Member of the Organizing Committee of the international conference μCHP 16 – micro cogeneration through biomass gasification, held at the Free University of Bozen-Bolzano on December 2nd and 3rd 2016.

2015 Member of the Organizing Committee of the international conference Building Simulation Applications - BSA 2015, held at the Free University of Bozen-Bolzano from February 4th to 6th 2015.

2013 Member of the organizing committee of the international conference Building Simulation Applications - BSA 2013, held at the Free University of Bozen-Bolzano from January 30th to February 1st 2013.

- **INSTITUTIONAL RESPONSIBILITIES**

2023 – now Faculty member, Free University of Bozen-Bolzano, Faculty of Engineering
Director of the Professional Bachelor in Wood Technology, Free University of Bozen-Bolzano, Faculty of Engineering
Teaching board member, Free University of Bozen-Bolzano, Faculty of Engineering

2022 – 2023 Faculty member, Free University of Bozen-Bolzano, Faculty of Science and technology

2018 – 2023 Vice-director of the Professional Bachelor in Wood Technology, Free University of Bozen-Bolzano, Faculty of Science and Technology

2023 – now Member of the Study Council of the PhD Program in "Food Engineering and Biotechnology", Free University of Bozen-Bolzano, Faculty of Agricultural, Environmental and Food Sciences

2017 – 2023 Member of the Study Council of the PhD Program in "Food Engineering and Biotechnology", Free University of Bozen-Bolzano, Faculty of Science and Technology

2016 – 2017 Member of the Study Council of the PhD Program in "Sustainable Energy and Technology, Free University of Bozen-Bolzano, Faculty of Science and Technology

- **REVIEWING ACTIVITIES (if applicable)**

2014 – now Member of the editorial board of Building Simulation Applications (BSA) Proceedings, a periodic publication (ISSN: 2531-6702) by bu,press, the publisher of the Free University of Bozen-Bolzano

2020 – 2022 Member of the Topical Advisory Panel of "Resources" journal (ISSN 2079-9276) by MDPI

2022 – now Member of the Editorial Board of "Resources" journal (ISSN 2079-9276) by MDPI

2022 – now Review Editor on the Editorial Board of Environmental Systems Engineering (specialty section of Frontiers in Environmental Science, ISSN 2296665X, IF 4.581)

2022 – now Review Editor on the Editorial Board of Waste Management (specialty section of Frontiers in Sustainability)

- **MEMBERSHIPS OF SCIENTIFIC SOCIETIES**

2018 – now Member of IBPSA, International Building Performance Simulation Association,

Chapter Italy
2016 – now Member of FTI, Associazione Italiana della Fisica Tecnica

- **MAJOR COLLABORATIONS**

  - *The City College of New York (CCNY, USA), Prof. Marco Castaldi*
  - *Bioenergy 2020+ | BEST, Wieselburg and Graz (Austria)*
  - *Ecole des Mines Albi-Carmaux (France), Prof. Ange Nzihou*
  - *KIT, Karlsruher Institut für Technologie (Germany), Prof. Reinhard RAUCH*
  - *DTU (Denmark), Prof. Ioannis SKIADAS, prof. Irini Angelidaki*
  - The *IMT Atlantique (France): Prof. Claire GERENTE & Prof. Audrey VILLOT*
  - *Cornell University, Ithaca (USA), Prof. Jillian GOLDFARB*
  - *Hiroshima University (Japan), Prof. Yukihiko MATSUMURA*
  - *University of the Aegean (Greece), Dr. Stergios VAKALIS*
  - *University of Trento, Prof. Luca Fiori*
  - *University of Trento, Prof. Maurizio Grigiante*
  - *University of Trento, Prof. Rosa Di Maggio*

Appendix: All current grants and on-going and submitted grant applications <u>of the PI</u> <u>and Co PI</u> (Funding ID)

<u>Mandatory information</u> (does not count towards page limits)

Current grants (Please indicate "No funding" when applicable):

Project Title	*Funding source*	*Amount (Euros)*	*Period*	*Role of the PI*	*Relation to current proposal*
CARNOT - Decarbonized and CirculAR hydrogeN prOducTion through biomass and waste gasification	Italian Ministry for Education and Scientific Research, MUR (PRIN 2022)	76 266	28/09/2023 - 27/09/2025	**unibz unit co-responsible** [PI: Unige, Italy; unibz unit responsible: Marco Baratieri]	Green hydrogen generation from biomass gasification
FRONTSH1P - A FRONTrunner approach to Systemic circular, Holistic & Inclusive solutions for a new Paradigm of territorial circular economy	European Commission, Horizon 2020 Framework Programme (Green Deal)	599 560 (16 118 418 whole consortium)	01/11/2021 – 30/09/2024	**unibz unit co-responsible** [PI: K-FLEX, Poland; unibz unit responsible: Marco Baratieri]	Gasification of waste wood and production of charcoal for multiple utilizations
Alps4GreenC - Implementation pathways for sustainable Green Carbon production in the Alpine Region	European Commission, Interreg Alpine Space Programme	119 350 (740 866 whole consortium)	01/09/2022 - 29/02/2024	**unibz unit co-responsible** [PI: CCIS, Slovenia; unibz unit responsible: Marco Baratieri]	Gasification of agri-food residues and production of biochar
RFD - Recupero di nutrienti dal processo HTC	European Regional Development Fund of the European Union and Autonomous Province of Bozen-Bolzano	173 842 (551 733 whole consortium)	01/09/2023 - 30/08/2025	**unibz unit responsible** [PI: HBI srl, Italy]	Gasification of hydrochar from HTC

	(ERDF 2021-2027)				
CDV - CompostDivino	European Regional Development Fund of the European Union and Autonomous Province of Bozen-Bolzano (ERDF 2021-2027)	154 510 (681 853 whole consortium)	03/01/2024 - 31/12/2026	**unibz unit co-responsible** [PI: Biologik srl, Italy; unibz unit responsible: Marco Baratieri]	Reuse of agricultural residues for heat production
SustainHEAT - Sustainable heating systems for decarbonizing buildings	European Regional Development Fund of the European Union and Autonomous Province of Bozen-Bolzano (ERDF 2021-2027)	318 179 € (1 120 008 € whole consortium)	01/10/2023 - 01/10/2026	**Project member** [PI: Eurac Research, Italy; unibz unit responsible: Massimiliano Renzi]	Development of infrastructure for advanced combustion measurements of syngas and renewable gas