cleanair2025

16th International Conference on Combustion Technologies for a Clean Environment

May 26 - 28 | 2025

CONFERENCE PROGRAMME

EDITED BY:

Pedro Coelho

IST CONGRESS CENTER | INSTITUTO SUPERIOR TÉCNICO | LISBOA | PORTUGAL

TITLE:

CLEAN AIR 2025 - CONFERENCE PROGRAMME
16th International Conference on Combustion Technologies for a Clean Environment

EDITED BY:

Pedro Coelho

Instituto Superior Técnico
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16th International Conference on Combustion Technologies for a Clean Environment

Contents

Preface

Welcome to the **16th International Conference on Combustion Technologies for a Clean Environment**, which is being held at Instituto Superior Técnico, Lisbon, Portugal, from May 26 to 28, 2025.

This conference addresses topics such as combustion fundamentals, reaction kinetics, laminar and turbulent flames, computational and experimental methods, liquid and solid fuels combustion, pyrolysis, gasification, engines, gas turbines, boilers and furnaces, CO2 capture processes, pollutants emission, alternative fuels, new combustion concepts, and machine learning application to combustion processes.

This book contains the conference programme and the abstract of the papers presented.

Use this link to access the papers presented at the conference:

https://cleanair2025.tecnico.ulisboa.pt/downloads/PAPERS.zip

Pedro Coelho, Roman Weber, Minghou Xu
CleanAir 2025 Conference Chairs

Sponsors

TÉCNICO LISBOA

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- **Feyza Kazanç Özerinç,** University of Illinois at Urbana-Champaign, *U.S.A*
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- **José Carlos Pereira,** Instituto Superior Técnico, Lisboa, *Portugal*
- **Luís Tarelho,** University of Aveiro, Aveiro, *Portugal*
- **Mara de Joannon,** Istituto di Ricerche sulla Combustione IRC-CNR, Naples, *Italy*
- **Maria Alzueta,** University of Zaragoza, Zaragoza, *Spain*
- **Milan Vujanovic,** University of Zagreb, Zagreb, *Croatia*
- **Mohy Mansour,** Cairo University, Cairo, *Egypt*
- **Neven Duic,** University of Zagreb, Zagreb, *Croatia*
- **Nilanjan Chakraborty,** University of Newcastle, *United Kingdom*
- **Norberto Fueyo,** University of Zaragoza, Zaragoza, *Spain*
- **Pascale Desgroux,** CNRS, PC2A, University of Lille, *France*
- **Peter Glarborg,** Technical University of Denmark, Lyngby, *Denmark*
- **Philippe Dagaut,** Centre National de la Recherche Scientifique, INSIS, Orléans, *France*
- **Sudarshan Kumar,** Indian Institute of Technology Bombay, Mumbai, *India*
- **Viktor Scherer,** Ruhr-Universitat Bochum, Bochum, *Germany*
- **Xue-Song Bai,** Lund University, *Sweden*

General Information

Registration Desk

The registration desk is located in the lobby of the Main Auditorium of the Congress Centre of Instituto Superior Técnico (IST) in floor 01. On-site payment by credit card and cash in Euros will be possible during registration. Personal cheques will not be accepted. The registration desk will be open according to the following schedule:

Monday, **26th May** 2025	09:00 - 18:00
Tuesday, **27th May** 2025	09:00 - 18:00
Wednesday, **28th May** 2025	09:00 - 17:30

Participation Certificates

Participation certificates will be sent by email immediately after the conference upon request to ***ritamaia@tecnico.ulisboa.pt***

Name Badges

Please use your name badge at all times, including technical sessions and social events.

Oral Presentations

The time allocated for the presentations is 50 minutes for the keynote lectures and 25 minutes for oral presentations, including the time for discussion. Laptops connected to LCD projectors are available. Speakers should bring their presentations on a USB flash drive in Microsoft PowerPoint format (*.ppt, *.pptx) or Adobe PDF format. The presentations must be delivered to the local staff and copied to the laptop of the room allocated to the presentation. First day speakers should deliver their presentations during the morning coffee break on Monday, May 26th. All the other presenters should do the same by the end of the previous session, even if the scheduled session is on the following day. Speakers may also connect their laptops directly to the projectors, but we cannot guarantee compatibility.

Coffee Breaks

Coffee breaks will be provided every morning and afternoon in Hall 02 between technical sessions.

Lunches

Buffet Lunch will be served daily in Hall 02.

Welcome Reception

The welcome reception will be held in Hall 02 at 18:00 on Monday (May 26).
The **IST Brewers Club** will make a demonstration of craft beer brewing during the welcome reception and beer tasting will be available.
The **TUIST** - Tuna Universitária do Instituto Superior Técnico (Music Students' Organization) will perform during the welcome reception.

Internet Access Credentials and Instructions

Login credentials:
Username: **CLEANAIR2025**
Password: **LsXABN**

1. Browse available wireless networks and select as SSID '**tecnico-guest**'.

2. Set IP to automatic (DHCP). This is usually the default setting, so you may probably skip this step.

3. Open your browser and try to access any external website. You will be automatically redirected to the page https://wifi.ist.utl.pt/index.php

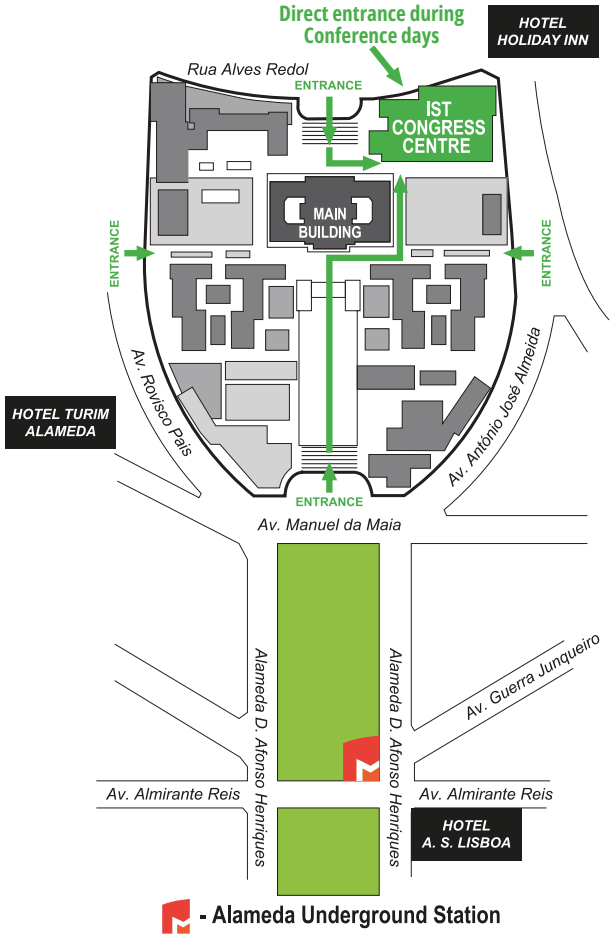
Follow the link 'Web based login' at the top of the page concerning short-time, conference, and meetings accounts. Enter the above username/password when requested.

4. After step 3 you may freely browse and access the Internet.

You may need to repeat the above steps if you close your browser or if the connection times out.

Map of Instituto Superior Técnico

With the location of the Congress Centre and nearby Hotels



Social Programme

Welcome Reception

CRAFT BEER TASTING | Monday, 26th May - 6 p.m. in Hall 02

Join us for a casual evening to meet other participants and celebrate the beginning of Clean Air 2025 with craft beer and music.

Craft Beer Tasting: Organized by the Técnico Beer Club (Clube de Cervejeiros do IST), this activity offers a guided tasting of a variety of craft beers. Participants will discover different beer styles, learn about brewing techniques, and enjoy the unique flavors of each selection.

Live Performance by TUIST: Enjoy a lively and traditional musical performance by TUIST, the university student music group (Tuna) from Instituto Superior Técnico. Experience the energy of academic Portuguese music and the joy of our student culture.

We can't wait to welcome you – let the music set the tone for an unforgettable start!

We look forward to seeing you there – cheers to new beginnings!

Social Programme

Conference Dinner

MUSEU DA CERVEJA RESTAURANT | Wednesday, 28th May 2025 - 8 p.m.

Located in Lisbon's historic Praça do Comércio (Terreiro do Paço), Museu da Cerveja Restaurant is dedicated to celebrating Portuguese gastronomy and the rich history of beer. Established in 2012, it offers visitors a unique blend of culinary delights and cultural insights.

Museu da Cerveja Restaurant

Address:
Terreiro do Paço – Ala Nascente, 62-65
1100-148 Lisbon

Location:
38° 42' 30" N | 9° 08' 08" W

Phone:
+351 210 987 656

Web:
https://www.museudacerveja.pt

Map of Lisboa

Network Map / Underground Lines

linha Azul Blue line

linha Amarela Yellow line

linha Verde Green line

linha Vermelha Red line

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PROGRAMME
SUMMARY

May 26 - 28 | 2025

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Programme Summary

Monday, 26th May

AUDITORIUM

09:00 - 09:30	**Registration**
09:30 - 10:00	**Opening Session**
10:00 - 10:50	**Keynote Lecture 1 –** *Simone Hochgreb*
10:50 - 11:10	*Coffee Break*
11:10 - 12:50	**Session 1 – LOW CARBON FUELS**
12:50 - 14:10	*Lunch*
14:10 - 15:00	**Keynote Lecture 2 –** *Christian Hasse*
15:00 - 16:15	**Session 2 – ALTERNATIVE FUELS I**
16:15 - 16:35	*Coffee Break*
16:35 - 17:50	**Session 3 – ALTERNATIVE FUELS II**
18:00 - 19:30	**Welcome Reception** *(Hall 02)*

Tuesday, 27th May

ROOM 02.1

09:30 - 10:20	**Keynote Lecture 3 –** *Alessandro Parente*
10:20 - 11:10	**Session 4 – MACHINE LEARNING APPLICATIONS TO COMBUSTION**
11:10 - 11:40	*Coffee Break*
11:40 - 12:30	**Session 5 – NEW COMBUSTION CONCEPTS**
12:30 - 14:00	*Lunch*
14:00 - 14:50	**Keynote Lecture 4 –** *Raffaele Ragucci*
14:50 - 16:05	**Session 6 – COMPUTATIONAL METHODS**
16:05 - 16:25	*Coffee Break*
16:25 - 17:40	**Session 7 – COMBUSTION DIAGNOSTICS**

Wednesday, 28th May

ROOM 02.1

09:00 - 09:50	**Keynote Lecture 5 –** *Dunxi Yu*
09:50 - 10:40	**Session 8 – SOLID FUELS COMBUSTION**
10:40 - 11:00	*Coffee Break*
11:00 - 12:00	**Poster session**
12:00 - 12.50	**Session 9 – REACTION KINETICS**
12:50 - 14:10	*Lunch*
14:10 - 15:00	**Keynote Lecture 6 –** *Luís Tarelho*
15:00 - 15:50	**Session 10 – PYROLYSIS AND GASIFICATION**
15:50 - 16:10	*Coffee Break*
16:10 - 17:25	**Session 11 – GAS TURBINES AND BOILERS**
17:25 - 17:40	**Closing Ceremony**
20:00 - 22:00	***Conference Dinner at Museu da Cerveja***

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TECHNICAL PROGRAMME

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Monday, 26th May

AUDITORIUM

09:00 - 09:30		**Registration**
09:30 - 10:00		**Opening Session**
10:00 - 10:50		**Keynote Lecture 1** **EMERGING ISSUES IN TURBULENT COMBUSTION OF LOW CARBON FUELS** ***Simone Hochgreb,*** University of Cambridge, Cambridge, *UK* Chair: ***Pedro Coelho***
10:50 - 11:10		*Coffee Break (Hall 02)*
		Session 1 **LOW CARBON FUELS** Chair: ***Simone Hochgreb***
11:10 - 11:35	PA-01	**SCALE UP AND SAFETY CASE STUDY OF A 500KW NH3/H2 SWIRL BURNER** *Jordan Davies, Syed Mashruk, Aravind Balakrishnan, Daisuke Sato, Sivachidambaram Sadasivam, Richard Marsh and Agustin Valera-Medina*
11:35 - 12:00	PA-02	**CLEAN FUEL AMMONIA COMBUSTION TECHNOLOGY IN NAPHTHA CRACKING FURNACES** *Naoki Ozaki, Terin Kanaumi, Kazuhiro Watanabe, Yoshihiko,Endo, Masahiro Kawasaki, Masafumi Minami And Hirofumi Imai*
12:00 - 12:25	PA-03	**EFFECTS OF INJECTION TIMING ON HYDROGEN-FUELED SPARK IGNITION ENGINE PERFORMANCE IN DIRECT INJECTION MODE** *Lia J. Pimont, Enrico R. M. Oliveira, Bruna L. S. Fontes, Fábio J. Dias, Alexander M. Penaranda, Frederico F. Weissinger, Leila R. Santos and Pedro T. Lacava*
12:25 - 12:50	PA-04	**COMBINED USE OF HYDROGEN AND REFUSE-DERIVED FUELS (RDF) IN ROTARY KILNS IN THE CEMENT INDUSTRY: A NUMERICAL STUDY ON THE INFLUENCE ON CLINKER QUALITY** *Henrik van Thriel, Dario Joschko, Kristina Fleiger and Viktor Scherer*
12:50 - 14:10		*Lunch (Hall 02)*
14:10 - 15:00		**Keynote Lecture 2** **GREEN IRON AND ALUMINUM AS RECYCLABLE ENERGY CARRIERS IN CIRCULAR ECONOMY - FROM GLOBAL OPPORTUNITIES TO SOLID FUEL COMBUSTION PHYSICS** ***Christian Hasse,*** Darmstadt University of Technology, Darmstadt, *Germany* Chair: ***Philippe Dagaut***
		Session 2 **ALTERNATIVE FUELS I** Chair: ***Christian Hasse***
15:00 - 15:25	PA-05	**HYDROGEN AND HEAT CO-GENERATION FROM A SWIRLED-STABILIZED ALUMINUM FLAME** *Lawrence Portugues, Cornelius Schönnenbeck, Jean-François Brihlac, Valérie Tschamber, Ulrich Schubert, Norbert Windhab, Elke Schweers and Olivier Allgaier*
15:25 - 15:50	PA-06	**PROPAGATION OF IRON DUST FLAMES WITH WALL INTERACTION AND VARYING INTER-PARTICLE DISTANCES** *Dr. Faizan Habib Vance, Dr.-Ing Arne Scholtissek, Dr.-Ing,Hendrik Nicolai and Prof. Dr.-Ing Christian Hasse*
15:50 - 16:15	PA-07	**FLAMELET MODEL DEVELOPMENT FOR IRON POWDER - METHANE FLAMES BASED ON FLAME REGIME ANALYSIS** *Pascal Steffens, Hendrik Nicolai and Christian Hasse*
16:15 - 16:35		*Coffee Break (Hall 02)*
		Session 3 **ALTERNATIVE FUELS II** Chair: ***Rafael Catapan***
16:35 - 17:00	PA-08	**HEAT TRANSFER CHARACTERISTICS OF CARBON-FREE FUELS FOR DECARBONIZATION OF HARD-TO-ABATE INDUSTRIES** *Giovanni Battista Ariemma, Tommaso Esposito, Giancarlo Sorrentino, Pino Sabia, Giuseppe Langella, Raffaele Ragucci and Mara de Joannon*
17:00 - 17:25	PA-09	**INTENSIFICATION OF BIODIESEL SYNTHESIS USING A PLASMA-ASSISTED CATALYTIC ROUTE** *Maíra Palm, Lucas Pavani, Diego Duarte and Rafael Catapan*
17:25 - 17:50	PA-10	**BABASSU COCONUT: COMPOSITION AND USES** *Bruno Leite Cruz, Regina Célia Espinosa Modolo and Carlos Alberto Mendes Moraes*
18:00 - 19:30		**Welcome Reception** *(Hall 02)*

Tuesday, 27th May

ROOM 02.1

09:30 -10:20		**Keynote Lecture 3** **DATA AND DIGITAL TWINS FOR SUSTAINABLE RENEWABLE FUEL COMBUSTION** ***Alessandro Parente,*** Université Libre de Bruxelles, Brussels, *Belgium* Chair: ***Pino Sabia***
		Session 4 **MACHINE LEARNING APPLICATIONS TO COMBUSTION** Chair: ***Alessandro Parente***
10:20 - 10:45	PA-11	**REAL-TIME PREDICTION AND OPTIMIZATION OF BOILER COMBUSTION PROCESS USING MACHINE LEARNING AND ONLINE DETECTION DATA** *Cong Wang, Jun Xu, Kai Xu, Long Jiang, Yi Wang, Sheng Su, Song Hu and Jun Xiang*
10:45 - 11:10	PA-12	**DATA-DRIVEN OPTIMIZATION OF SUSTAINABLE AVIATION FUEL COMPOSITION FOR THE MINIMIZATION OF CONTRAIL FORMATION AND POLLUTANT EMISSIONS** *Ana Larrañaga, James R. MacDonald, Steven L. Brunton, Jacobo Porteiro and Darío Lopez-Pintor*
11:10 - 11:40		*Coffee Break (Hall 02)*
		Session 5 **NEW COMBUSTION CONCEPTS** Chair: ***Raffaele Ragucci***
11:40 - 12:05	PA-13	**INVESTIGATION OF FUEL FLEXIBILITY OF A STAGNATION-POINT REVERSE FLOW GAS TURBINE COMBUSTOR** *Mohamed Salah Eddine Salah, M. Mustafa Kamal, Lyes Tarabet and Alessandro Parente*
12:05 - 12:30	PA-14	**PLASMA ENHANCED ELECTROSPRAY FOR FUEL INJECTION SYSTEMS** *Miguel Moreira, Frederico Rodrigues and José Páscoa*
12:30 - 14:00		*Lunch (Hall 02)*
14:00 - 14:50		**Keynote Lecture 4** **ENERGY AND MOBILITY SUSTAINABILITY** ***Raffaele Ragucci,*** STEMS - CNR, Naples, *Italy* Chair: ***Miguel Mendes***
		Session 6 **COMPUTATIONAL METHODS** Chair: ***José Carlos Pereira***
14:50 - 15:15	PA-15	**EFFECT OF THE KINETIC MECHANISM ON THE FLAME STRUCTURE PREDICTION UNDER MILD CONDITIONS** *Pedro Ramos, Duarte Albuquerque and José Pereira*
15:15 - 15:40	PA-16	**TURBULENT COMBUSTION ANALYSIS ON A CAPSTONE C30 MICRO-GAS-TURBINE FUEL INJECTOR USING NATURAL GAS AND HYDROGEN** *Ailton D. Gonçalves, Luciano Bueno, Marcelo Martins, Edgar Fernandes and Guilherme Gaspar*
15:40 - 16:05	PA-17	**AN OPTIMIZATION METHOD FOR ANGLE SETS IN WIDE-ANGLE LIGHT SCATTERING MEASUREMENT OF PARTICLE SIZE DISTRIBUTION** *Yubo Huang, Xiaowei Liu and Minghou Xu*
16:05 - 16:25		*Coffee Break (Hall 02)*
		Session 7 **COMBUSTION DIAGNOSTICS** Chair: ***Edgar Fernandes***
16:25 - 16:50	PA-18	**FLAME VISUALIZATION AND OPTICAL SENSING TECHNIQUES FOR DETECTING HYDROGEN-METHANE CO-COMBUSTION FLAMES** *Young Bae Kim, Young Sik Jeong and Ho Kyun Lee*
16:50 - 17:15	PA-19	**DETERMINING THE REACTION ENTHALPY IN PYROLYSIS AND COMBUSTION AT REALISTIC PROCESS CONDITIONS** *Raymond Chen and Ewa J. Marek*
17:15 - 17:40	PA-20	**SOOT AND SPRAY CHARACTERISTICS OF SWIRL-STABILIZED JET A-1 FLAMES WITH SECONDARY AIR INJECTION** *Ritesh K. Maurya and Ömer L. Gülder*

Wednesday, 28th May

ROOM 02.1

09:00 - 09:50		**Keynote Lecture 5** **COFIRING BIOMASS WITH COAL IN CHINA: PROGRESS, PERSPECTIVES AND CHALLENGES** ***Dunxi Yu,*** Huazhong University of Science and Technology, Wuhan, *China* Chair: ***Anders Brink***
		Session 8 **SOLID FUELS COMBUSTION** Chair: ***Dunxi Yu***
09:50 - 10:15	PA-21	**EFFECTS OF ISOTHERMAL AND NON-ISOTHERMAL PYROLYSIS ON TAR REMOVING DURING STEAM REFORMING OF PINE WOOD** *Wei Deng, Junmeng Li, Kai Xu, Jun Xu, Long Jiang, Sheng Su, Song Hu, Yi Wang and Jun Xiang*
10:15 - 10:40	PA-22	**AN EXPLORATORY STUDY OF THE INTERACTIONS BETWEEN PHOSPHORUS ADDITIVES AND POTASSIUM SPECIES UNDER PYROLYSIS CONDITIONS** *Wenkai Zhang, Emil Olsson, Peter Glarborg, Kim Johansen, Songgeng Li, Tooran Khazraie, Juha Roppo and Hao Wu*
10:40 - 11:00		*Coffee Break (Hall 02)*
11:00 - 12:00		**Poster Session** *(Hall 02)*
		Session 9 **REACTION KINETICS** Chair: ***Rogério dos Santos***
12:00 - 12:25	PA-23	**ON THE OXIDATION OF 2,5-DIMETHYLFURAN IN A JET-STIRRED REACTOR AT 1 BAR** *Philippe Dagaut and Guillaume Dayma*
12:25 - 12:50	PA-24	**LOW-ORDER KINETIC MODELS FOR RCD PROCESSES WITH ORIGINAL ELEMENTARY REACTIONS** *Pino Sabia, Maria Virginia Manna, Giovanni Battista Ariemma, Mara de Joannon and Raffaele Ragucci*
12:50 - 14:10		*Lunch (Hall 02)*
14:10 - 15:00		**Keynote Lecture 6** **THERMOCHEMICAL CONVERSION OF BIOMASS, PYROLYSIS, GASIFICATION** ***Luís Tarelho,*** University of Aveiro, Aveiro, *Portugal* Chair: ***Ana Filipa Ferreira***
		Session 10 **PYROLYSIS AND GASIFICATION** Chair: ***Luís Tarelho***
15:00 - 15:25	PA-25	**NUMERICAL MODELING OF THE BIOMASS PYROLYSIS PROCESS IN AUGER REACTOR USING DEM METHOD** *Sławomir Sładek, Adam Klimanek, Michał Chabiński, Agnieszka Korus, Robert Daschner, Christian Groves and Andrzej Szlęks*
15:25 - 15:50	PA-26	**DESIGN OF A PYROLYSIS GAS CLEANING SYSTEM FOR OXYFUEL COMBUSTION WITH PRIOR HYDROGEN EXTRACTION** *Christian Groves, Shimul Hossain, Sanjay Mundanattu Prasad, Felix Lehner and Martin Meiller*
15:50 - 16:10		*Coffee Break (Hall 02)*
		Session 11 **GAS TURBINES AND BOILERS** Chair: ***Jacobo Porteiro***
16:10 - 16:35	PA-27	**CFD STUDY OF A PREMIXED HYDROGEN DOMESTIC BOILER** *David García-Rodiño, César Álvarez-Bermúdez, Sergio Chapela, David Patiño and José Luis Míguez*
16:35 - 17:00	PA-28	**A REACTOR-NETWORK MODEL FOR NITROGEN CHEMISTRY IN THE FREE-BOARD OF BIOMASS BOILERS** *Amirreza Mottaghitalab and Anders Brink*
17:00 - 17:25	PA-29	**EFFECT OF WATER INJECTION ON THE IGNITION AND FLAME STABILITY OF AFTERBURNER** *Yue Chen, Fan Yuxin and He Pengyu*
17:25 - 17:40		**Closing Ceremony**
20:00 - 22:00		***Conference Dinner at Museu da Cerveja***

Poster Session (Wednesday, 28th May) HALL 02

11:00 - 12:00	PP-01	**DESIGN AND NUMERICAL ANALYSIS OF LOW-NOX HYDROGEN BURNERS UTILIZING RECTANGULAR FLAME PORTS FOR ENHANCED TEMPERATURE CONTROL** *Young Bae Kim and Young Sik Jeong*
	PP-02	**ARTIFICIAL INTELLIGENCE FOR OXY-FLAME DESIGN AND FLAME SHAPE PREDICTION** *Gorkem Oztarlik, Wentan Wu and Arthur Degeneve*
	PP-03	**EXPERIMENTAL STUDY ON AMMONIA/HYDROGEN COMBUSTION IN A SEMI-INDUSTRIAL FURNACE: INFLUENCE OF EQUIVALENCE RATIO** *Natalia Cid, Ebrahim Rahmani, Marco Lubrano Lavadera and Alessandro Parente*
	PP-04	**KINETIC MECHANISM FOR HYDROGEN FLAMES UNDER TRANSCRITICAL/SUPERCRITICAL STATE WITH REAL GAS EQUATION** *Andreza Costa, Paulo Vitor Ribeiro Plácido and Rogerio Gonçalves dos Santos*
	PP-05	**EXPERIMENTAL INVESTIGATION OF LEAN ETHANOL COMBUSTION WITH HYDROGEN ENRICHMENT IN OPTICALLY ACCESSIBLE SPARK IGNITION ENGINE** *Bruna L. S. Fontes, Enrico R. M. Oliveira, Lia J. Pimont, Fabio J. Dias, Alex M. Penaranda, Frederico F. Weissinger, Leila R. Santos and Pedro T. Lacava*
	PP-06	**CFD STUDY OF A MODULAR PREMIXED HYDROGEN COMBUSTION PILOT PLANT** *David García-Rodiño, César Álvarez-Bermúdez, Sergio Chapela, Miguel Ángel Gómez and José Luis Míguez*
	PP-07	**CFD MODELING OF AMMONIA FUELED MICRO GAS TURBINE COMBUSTOR – DESIGN CONSIDERATIONS AND PREDICTIONS OF POLLUTANTS FORMATION** *Adam Klimanek, Sławomir Sładek, Wojciech Adamczyk and Andrzej Szlęk*
	PP-08	**EXPERIMENTAL AND NUMERICAL ANALYSIS OF A LOW-SWIRL BURNER FOR CERAMICS' INDUSTRY** *André Antunes, Francisco Dinis and Edgar Fernandes*
	PP-09	**CHARACTERISATION OF JET FIRES OF HYDROGEN AND METHANE BLEND USING DIFFERENT APPROACHES: EXPERIMENTAL, SIMULATION AND RISK PERSPECTIVE** *Mário A. Silva, Filipe Mil-Homens, Ricardo Bernardino, Megan Dlima, Nuno Canha, Edgar Fernandes*
	PP-10	**CHARACTERISATION OF A PORTABLE ON-LINE READING OXIDATIVE POTENTIAL DEVICE USING RESIN-BASED 3D PRINTING TECHNOLOGY** *Antonio Guido Toto, Guillaume Suarez, Jean-Jacques Sauvain and Nicolas Concha-Lozano*
	PP-11	**THERMALLY DRIVEN PROCESSES CO2 CAPTURE: A LIFE CYCLE ASSESSMENT PERSPECTIVE** *Leandro Magalhães, Sofia Nunes and Ana Filipa Ferreira*
	PP-12	**COGENERATION AND OXY-FUEL SYSTEMS: A SUSTAINABLE APPROACH TO ENERGY EFFICIENCY AND EMISSION REDUCTION** *Ahmed Alharbi*
		COMBUSTION OPTIMIZATION FOR WASTE-TO-ENERGY AND BIOMASS-TO-ENERGY PLANTS *Damir Zibrat*
		PRELIMINARY INVESTIGATION ON THE INFLUENCE OF SiO_2 ON THE CARBOTHERMIC REDUCTION OF POTASSIUM PHOSPHATES *Qi Li, Hao Wu and Emil Olsson*

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KEYNOTE LECTURES

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EMERGING ISSUES IN TURBULENT COMBUSTION OF LOW CARBON FUELS

Simone Hochgreb
University of Cambridge, Cambridge, *UK*

ABSTRACT

Energy systems across the world are changing at a fast pace, with demands for low or zero net carbon energy conversion. Wind and solar dominate the growth of primary energy delivery, while a number of solutions are proposed for the particularly difficult problems of long-term seasonal storage. Hydrogen, ammonia and liquid synthetic fuels are proposed solutions, although their production costs are still outside the competitive range.

An increasing number of studies on laminar and turbulent combustion of such fuels have been launched to both understand their properties relatively to well-studied fossil fuels. The investigations have opened further windows into the role of differential diffusion of both large and small molecular weight fuels in turbulent combustion, as well as the continuing challenges of predictions in the combustion of blends.

In this talk, we will survey at the current state of the art in experimental and modeling studies of low carbon fuels and blends, showing successes and pointing the way to further challenges.

Simone Hochgreb is a Professor of Engineering at the University of Cambridge. Her main research interests are in understanding processes in combustion and reacting flows, as relevant to power conversion and industrial processes. She has co-authored around 200 journal publications in engine and gas turbine combustion, reacting flows, measurement methods and thermoacoustics.
Her recent interests are in the application of optical diagnostics to the measurements of temperatures and species in turbulent flames, hydrogen combustion, thermoacoustics, aerosols and flame synthesis. She is a Fellow of the Combustion Institute, and of the Royal Aeronautical Society, and Distinguished Fellow of the International Institute of Acoustics and Vibration.

GREEN IRON AND ALUMINUM AS RECYCLABLE ENERGY CARRIERS IN CIRCULAR ECONOMY - FROM GLOBAL OPPORTUNITIES TO SOLID FUEL COMBUSTION PHYSICS

Christian Hasse

Darmstadt University of Technology, Darmstadt, *Germany*

ABSTRACT

The transformation to a net-zero carbon society is one of the most pressing challenges of our time. Green metal fuels, produced from metal oxides using renewable energy, are emerging as a carbon-free, high energy density replacement for fossil fuels due to their availability and recyclability. Iron and aluminum in particular iron and aluminum are promising options for a carbon-free cycle since they are non-toxic, safe to transport, easy to store, abundant, and in principle can be recycled an unlimited number of times.

This plenary will deliver two key messages:

1. Iron and aluminum are promising carriers of renewable energy for a net-zero carbon society.

2. While previous work on solid carbonaceous fuels provides an excellent starting point for studying metals as energy carriers, the physics of iron and aluminum combustion is quite different, fascinating, and largely unexplored.

In the first part, iron and aluminum are introduced as a recyclable chemical energy carrier. During the reduction of metal oxides, energy from renewable sources such as wind, hydro, and solar is stored. This energy is released again through combustion in air or steam. This yields either high-temperature heat (air) or high-temperature heat and hydrogen (steam). The product of this zero-CO2 combustion process is solid metal oxide. One promising application of metals is the retrofit of existing infrastructure. This is demonstrated with a thermodynamic system analysis for a coal-fired power plant to be operated with iron powder in the future. This is followed by a techno-economic analysis, for which different partner countries for reduction and oxidation are considered. Hydrogen and iron are compared as energy carriers based on round-trip efficiency and levelized cost of electricity

In the second part, selected experimental and numerical results on the combustion physics are presented. First, the oxidation of single iron particles is showcased, and the different phases of ignition and combustion are discussed with a special focus on the coupling of gas phase transport with the condensed phase kinetics. Similarly, the fascinating physics of aluminum-steam combustion are explored. Going towards multidimensional flames, discrete and continuous flame propagation modes are analyzed. Finally, results for turbulent iron-air flames are presented. The need for well-controlled and well-characterized experimental conditions to reduce uncertainties is demonstrated by comparison to simulation results.

Prof. Hasse is head of the Institute for the Simulation of Reactive Thermo-Fluid Systems (www.stfs.tu-darmstadt.de) at Darmstadt University of Technology. From 2010-2017 he was full professor at the Technische Universität Bergakademie Freiberg. From 2004-2010 he worked at BMW in engine development and exhaust aftertreatment. He received his doctorate at RWTH Aachen University in 2004 (supervisor: Norbert Peters).
He has successfully supervised 32 PhD students and currently 30 PhD students and post-docs are working in his group in Darmstadt. His main research interests are combustion theory, modeling and simulation with application to technical systems such as aero-engines, gas turbines, IC engines, furnaces, and reactors in process engineering. He has published over 280 peer-reviewed journal papers. He is Fellow of the International Combustion Institute for his contributions to turbulent combustion, solid fuel combustion, multi-phase flows and soot formation. He was elected to the Board of Directors of the International Combustion Institute in 2024.
Since 2021, he is spokesperson of the collaborative research project "Clean Circles – Reactive Metals as Carbon-free Energy Carriers in a Circular Energy Economy" with more than 50 scientists. He received an ERC Advanced Grant for his proposal A-STEAM – Aluminum STEAM Combustion for Clean Energy in 2024.

DATA AND DIGITAL TWINS FOR SUSTAINABLE RENEWABLE FUEL COMBUSTION

Alessandro Parente

Université Libre de Bruxelles, Brussels, *Belgium*

ABSTRACT

Decarbonizing industrial heat, particularly in sectors like steel, glass, cement, and aluminium, presents a critical challenge in the pursuit of global energy transition goals. This challenge is amplified by the reliance of these industries on high-temperature heat, which is difficult to electrify, making the exploration of alternative decarbonization strategies essential. Digital twins have emerged as a powerful tool with the potential to revolutionize the modelling and optimization of complex combustion systems in these industries. By integrating physics-based constraints, data assimilation techniques, and sparse sensing, digital twins can provide accurate and reliable predictions of system behaviour under various operating conditions.

This presentation delves into the development and application of digital twins for practical combustion systems, with a focus on enhancing their predictive capabilities for improved efficiency and reduced emissions. We explore the use of physics-based, data-driven approaches for the development of digital twins capable of continuously integrating heterogeneous data streams and providing estimates of prediction uncertainties.

Alessandro Parente earned his Master's (2005) and PhD (2009) in Chemical Engineering from the Università di Pisa. He was a Research Associate at the University of Utah (2007–2009) and joined the von Karman Institute in 2009. Since 2010, he has been at the Université Libre de Bruxelles, where he became Professor in 2019. Co-chair of the Brussels Institute for Thermal-Fluid Systems and Clean Energy (BRITE) since 2021, his research spans experimental and numerical studies of reacting and non-reacting flows, with applications in air quality and industrial decarbonization. He also leads efforts in using machine learning to enhance fluid flow simulations and develop digital twins, coordinating a European network (cypher.ulb.be) for decarbonizing hard-to-abate sectors.

ENERGY AND MOBILITY SUSTAINABILITY

Raffaele Ragucci
STEMS - CNR, Naples, *Italy*

ABSTRACT

Energy and Mobility sectors are responsible for more than 3/4 of the global green-house gases emissions. Combustion is still widely used in many so called “hard-to-abate” sectors. They include both energy production and energy intensive industrial sectors as well as terrestrial, marine and aeronautical propulsion systems. While it is commonly forecasted that combustion free processes and technologies will allow for a significant reduction of GHG emissions, the present picture hardly suggests that this goal will be reached in the next decade. According to realistic scenarios combustion will continue to play a central role in many industrial sectors and will be used in propulsion for many years to come. Cleaner combustion processes, carbon neutral fuels exploitation, efficient and fuel flexible processes and devices will be still developed in the next years. The lecture aims to outline the main motivations and critical issue that research in combustion has to face with to support this developments.

Raffaele Ragucci is a research director at Institute of Science and Technology for Sustainable Energy and Mobility (STEMS) of CNR. He worked along the years on several combustion related topics. Among others, liquid atomization, optical diagnostics, gaseous and liquid combustion, MILD combustion as well as biomass pyrolysis.

COFIRING BIOMASS WITH COAL IN CHINA: PROGRESS, PERSPECTIVES AND CHALLENGES

Dunxi Yu

Huazhong University of Science and Technology, Wuhan, *China*

ABSTRACT

The extensive utilization of coal in China is the major reason for the large emissions of CO2. To achieve the ambitious goals of "carbon peak and carbon neutrality", decarbonization of coal-fired power generation is an important and urgent task. China has abundant biomass reserves, but its utilization is still at a low level. Using biomass to partly or completely replace coal can not only increase renewable energy utilization, but also accelerate the decarbonization of coal-fired power generation, which has great strategic significance for building a new and sustainable power system. Since the 1990s, biomass-coal cofiring technologies have been greatly developed and widely applied in developed countries and regions such as Europe, the United States, and Japan, with the United Kingdom even achieving 100% biomass combustion in large coal-fired power plants. In comparison, China's experience in this area is still very limited. However, in recent years, the Chinese government has successively promulgated a number of policies to encourage cofiring biomass with coal for power generation.

This presentation first introduces the progress in practicing biomass-coal cofiring in China. Secondly, the significant importance and broad prospects of this technology in China's "carbon peak and carbon neutrality" strategy are elaborated. Finally, it points out the challenges associated with cofiring biomass at high ratios, and discuss possible countermeasures based on international experiences.

Prof. Dunxi Yu is the deputy director of the State Key Laboratory of Coal Combustion, Huazhong University of Science and Technology (HUST), China. He received his Master's (2002) and PhD (2007) degrees in Thermal Engineering from HUST. From 2009-2011, he worked as a postdoctoral researcher under the supervision of Prof. Jost Wendt at the University of Utah, USA. He became a full professor at HUST in 2013. He is interested in clean and high-efficiency utilization of diverse fuels such as coal, biomass and carbonaceous wastes. In recent years, interests have also been developed in cofiring hydrogen and ammonia in coal-fired power plants. He has published over 180 peer-reviewed journal papers, and owned more than 15 patents. He won the second prize of National Natural Science Award in 2024 for his contributions to pollutant abatement in combustion.

THERMOCHEMICAL CONVERSION OF BIOMASS, PYROLYSIS, GASIFICATION

Luís Tarelho
University of Aveiro, Aveiro, *Portugal*

ABSTRACT

Thermochemical conversion of biomass to energy vectors and organic products will be analysed in this presentation. The process and technology of pyrolysis, gasification and combustion. are analysed with focus on main technologies and most relevant products and some of their applications. Biomass combustion for heat and power production, pyrolysis for biochar, bio-oil and gas production and gasification for producer gas production will be addressed. The technology of fluidized bed reactors for combustion and gasification and auger reactors for pyrolysis processes will be analysed. The analysis is supported also with examples of extended research topics that have been developed at University of Aveiro, Portugal.

Licentiate in Environment Engineering and PhD in Environment Applied Sciences at University of Aveiro, Portugal.
Associate Professor in Environmental Sciences and Engineering – Environment Technology, at the Department of Environment and Planning, University of Aveiro.
Coordinator of the Research Cluster Circular Economy, Resources and Energy Optimization (https://www.cesam-la.pt/en/research-groups/rg6/) at the Associate Laboratory Centre for Environmental and Marine Studies (CESAM) at University of Aveiro. http://www.cesam.ua.pt/tarelho.
Main research expertise is in the field of biomass to energy and valorisation (material and energetic) of solid wastes and alternative gaseous fuels. Expertise in developing and optimization of thermochemical (combustion, gasification, and pyrolysis) processes and technologies for energetic conversion of biomass (including sewage sludge and solid wastes) to energy vectors and bio-products and its integration in industrial processes, namely thermal energy and gaseous and liquid fuels, and bio-products (e.g., biochar), and related measures to mitigate environmental impacts. Expertise in developing bench-scale facilities for processes characterisation and optimization, and prototypes and pilot-scale facilities for demonstration of the technology of thermochemical conversion of biomass to energy. Expertise in bubbling fluidised bed reactors. Collaboration with industrial partners, as the pulp and paper industry and the electric energy production industry, and other industrial sectors as the charcoal production, in order to optimize the processes and technology at industrial scale, and also collaboration with international R&D partners, e.g., in Sweden, Brazil, Spain.


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