

# Future Powertrains for Sustainable & Clean on Road Mobility

## Politecnico di Torino 10<sup>th</sup> - 13<sup>th</sup>-14<sup>th</sup> March 2025

### DAY1: Setting the stage – Latest Regulations and Technologies

#### TOPICS:

- **Setting the stage:** *Dr. Ameya Joshi*, Mobility Notes
- **Regulations:** *Prof. Zissis Samaras*, Aristotle University, Thessaloniki
- **Criteria Pollution Control – Gas Emissions:** *Dr. Maria Pia Ruggeri*, Johnson Matthey
- **Criteria Pollution Control – Particulates:** *Dr. Ameya Joshi*, Mobility Notes

### DAY3: Putting it all together - lifecycle approaches, summary:

#### TOPICS:

- **Renewable and E-Fuels:** *Prof. Dr.-Ing. André Casal Kulzer*, University of Stuttgart
- **Lifecycle analysis (LCA) + TCO:** *Dr. Amgad Elgowainy*, Argonne National Laboratories
- **Hands-on GREET:** *Dr. Amgad Elgowainy*, Argonne National Laboratories

### DAY2: Advanced Technologies for Transport Decarbonization

#### TOPICS

- **Electrified Powertrains:** *Prof. Giorgio Rizzoni*, The Ohio State University
- **Hydrogen fuel cells:** *Prof. Massimo Santarelli*, Politecnico di Torino
- **Battery Electric:** *Prof. Silvia Bodoardo*, Politecnico di Torino

### Highlights

#### Who can attend:

- Ph.D. students and young professionals

#### Visits: Battery Tech Center @ Stellantis

**DUMAREY**



Center for  
Automotive Research  
and Sustainable Mobility



**Politecnico  
di Torino**

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Limited seats available - Register at <https://forms.gle/fP1rFdS3EyvbFVz48>

Interested in H2 ICEs ? Don't miss the Hydrogen for Sustainable Mobility Forum on March 11 - 12, 2025 <https://www.eventleaf.com/e/H2SMForum2025> !

## Day 1 (March 10<sup>th</sup>): Setting the stage – Latest regulations and technologies

Time	Topic	Speaker
9:00 a.m. – 9:30 a.m.	Introduction to course	Prof. F. Millo, PoliTO
9:30 a.m. – 10:30 a.m.	Setting the stage	Dr. A. Joshi, Mobility Notes
10:30 a.m. – 11 a.m.	Coffee Break	
11 a.m. – 12:30 p.m.	Regulations	Prof. Z. Samaras, Aristotle Univ., Thessaloniki
12:30 p.m. – 2:00 p.m.	Lunch Break	
2:00 p.m. – 3:30 p.m.	Criteria Pollution Control – Gas Emissions	Dr. Maria Pia Ruggeri, Johnson Matthey
3:30 p.m. – 4:00 p.m.	Coffee Break	
4:00 p.m. – 5:30 p.m.	Criteria Pollution Control – Particulates	Dr. A. Joshi, Mobility Notes

# DAY1: Setting the stage – Latest Regulations and Technologies

## Speakers' Bios

### Dr. Ameya Joshi



Dr. Ameya Joshi is an experienced technology leader with ~20 years of expertise providing strategic direction in transport decarbonization. He is the founder of MobilityNotes, an online platform which delivers unbiased information and consulting for all aspects of transport decarbonization.

He was previously the Vice President of Product & Strategic Partnerships at ClearFlame Engines and the Director of Emerging Technologies at Corning.

He has nearly two decades of experience in the field of transport decarbonization and emissions control. Ameya delivered the Buckendale lecturer at SAE COMVEC in 2022, and serves on the Editorial Board of several SAE journals.

Ameya has a Ph.D. from the University of Delaware and pursued postdoctoral work in the field of fuel cells at the Colorado School of Mines.

### Prof. Zissis Samaras



Professor Zissis Samaras was the Director of the Lab of Applied Thermodynamics, Aristotle University until 2023. His research work deals with engine and vehicle emissions testing and modeling and exhaust aftertreatment. As a scientific coordinator, he has secured funding of over 30 million euros from more than 250 European and national projects and has led more than 10 large European projects, including “Characterisation of Particulate Emissions”, “Methodology to Evaluate the Impact of ICT on Road Emissions”, “Measuring Exhaust Particles Down to 10nm”, “Smart Anti-tampering Systems” and “Tailpipe and Brake Emissions Retrofits”. He was elected Vice Chairman of ERTRAC, the European Road Transport Research Advisory Council (until 2023) and co-led for many years the UN-ECE Topic Group "Mobile Sources". He co-authored more than 280 publications, with more than 7300 citations (author h index 48) and holds four international patents. He is the co-founder of three spin-off companies Exothermia (now owned by Gamma Technologies), Emisia and Bio2CHP. Currently he leads a consortium that advises the European Commission on Euro 7 related topics.

### Dr. Maria Pia Ruggeri



Dr. Maria Pia Ruggeri works in the role of Technical Expert in heterogenous catalysis for the development of exhaust gas aftertreatment systems at Johnson Matthey. In this role, she applies her 15 years of experience in fundamental knowledge of aftertreatment catalysis to a range of diesel and alternative fuels technologies in support of R&D and customer programs. She joined Johnson Matthey in 2015 after having achieved a PhD in chemical engineering and industrial chemistry from Politecnico di Milano, with a thesis on modelling and mechanistic studies of different NH<sub>3</sub>-SCR technologies. During her MSc and PhD, she conducted a number of international research assignments, including one at the Heyrovsky Institute of Physical Chemistry in Prague and one at the National Transportation Research Centre (Oak Ridge National Laboratory) in Tennessee. Since joining Johnson Matthey, she has worked on a range of diesel technologies and lead a team of PhD chemists working on SCR and other NO<sub>x</sub> control technologies (2019-2024), while maintaining links with academia. With the expectation of increased prevalence of H<sub>2</sub>-ICE and alternative fuels in the near future, her research has now broadened to incorporate this new and exciting area.

# DAY1: Setting the stage – Latest Regulations and Technologies

## Highlights

### **Setting the stage**

Dr. Ameya Joshi, Mobility Notes

This will introduce the topics covered in the course and provide the “why” for pursuing various technologies for decarbonizing transport. We will touch upon various pollutants, regulations limiting their emissions across all transport sectors, provide a high-level overview of the technologies being pursued to meet the air quality goals, and identify some of the pressing challenges.

### **Regulations**

Prof. Zissis Samaras, Aristotle University, Thessaloniki

- Euro 7 in the framework of road vehicle defossilization: Emission limits and deployed technologies, On-board monitoring, Anti-tampering, security and cybersecurity, On board fuel consumption for both ICE and BEV, Non-Exhaust Emissions (brake particle emissions and tyre abrasion), Battery durability, Environmental vehicle passport
- LCA methodology and voluntary OEM reporting
- LCA based Impact Assessment

### **Criteria Pollution Control – Gas Emissions**

Dr. Maria Pia Ruggeri, Johnson Matthey

This module will cover the basics for the design of effective aftertreatment systems for different fuels emissions (Gasoline, Diesel and H<sub>2</sub>, NH<sub>3</sub>, CNG, and Methanol):

- What is an aftertreatment catalyst? From powders to honeycomb flow throughs and coated filters.
- Catalyst design toolbox: from catalyst preparation to testing & characterisation.
- Gasoline emissions & Three Way Catalysts: what are the challenges?
- Diesel aftertreatment systems: DOC (Diesel oxidation catalyst), CSF (Catalytic Soot Filter), SCR (Selective Catalytic Reduction), ASC (Ammonia Slip Catalysts) and how to combine them to meet legislation targets.
- Designing catalysts for alternative fuels for the future of mobility.

### **Criteria Pollution Control - Particulates**

Dr. Ameya Joshi, Mobility Notes

This section will provide an introduction to in-cylinder and after-treatment options for minimizing particulate emissions from a modern engine. We will cover impact of fuels, injection systems, and ultimately the design principles of a modern particulate filter, as a component of both light- and heavy-duty engine after-treatment systems. We will review the filter and material characteristics which enable high filtration, low backpressure and efficient regeneration. We will also cover the impact of a catalyzed filter in the context of enabling combined gas emissions conversion and particulate filtration.

## Day 2 (March 13<sup>th</sup>): Advanced Technologies for Transport Decarbonization

Time	Topic	Speaker
9 a.m. – 10:30 a.m.	Electrified Powertrains	Prof. G. Rizzoni, Ohio State Univ.
10:30 a.m. – 11 a.m.	Coffee Break	
11 a.m. – 1 p.m	Hydrogen fuel cells	Prof. M. Santarelli, PoliTO
1 p.m. – 2:30 p.m.	Lunch Break	
2:30 – 4:00 p.m.	Lab Visits: Battery Tech Center	Stellantis
4:00 p.m. – 17:30 p.m.	Battery Electric	Prof. S. Bodoardo, PoliTO

# DAY2: Advanced Technologies for Transport Decarbonization

## Speakers' Bios



### **Prof. Giorgio Rizzoni**

Giorgio Rizzoni, the Ford Motor Company Chair in ElectroMechanical Systems, is a Professor of Mechanical and Aerospace Engineering and of Electrical and Computer Engineering at The Ohio State University (OSU). He received his B.S. (ECE) in 1980, his M.S. (ECE) in 1982, his Ph.D. (ECE) in 1986, all from the University of Michigan. Since 1999 he has been the director of the Ohio State University Center for Automotive Research (CAR), an interdisciplinary university research center in the OSU College of Engineering. His research activities are related to modeling, control and diagnosis of advanced propulsion systems, vehicle fault diagnosis and prognosis, electrified powertrains and energy storage systems, vehicle autonomy, safety and intelligence, and sustainable mobility. He has contributed to the development of graduate curricula in these areas, and has served as the director of three U.S. Department of Energy Graduate Automotive Technology Education Centers of Excellence: Hybrid Drivetrains and Control Systems (1998-2004), Advanced Propulsion Systems (2005-2011, and Energy Efficient Vehicles for Sustainable Mobility (2011-2016). Between 2011 and 2016 he served as the OSU Site Director for the U.S. Department of Energy China-USA Clean Energy Research Center - Clean Vehicles. He is currently leading an ARPA-E project in the NEXTCAR program with the aim of advancing energy efficiency in connected and automated vehicles. During his career at Ohio State, Prof. Rizzoni has directed externally sponsored research projects funded by major government agencies and by the automotive industry in approximately equal proportion. Prof. Rizzoni has to date advised 45 PhD and 110 MS students, is a Fellow of IEEE (2004), SAE (2005), and ASME (2022), a recipient of the 1991 National Science Foundation Presidential Young Investigator Award, and of many other technical and teaching awards.



### **Prof. Massimo Santarelli**

Prof. Massimo Santarelli, Mechanical Engineer, Ph.D. in Thermodynamics and Heat Transmission, Full Professor of Thermodynamics and Heat Transmission, Energy Department, Politecnico di Torino. Coordinator of PhD School in Energy. Author of around 330 papers in international journals (h-index 60 @January 2025). The main research activity is related to the topic of complex innovative systems (thermochemical and electrochemical processes) applied to the energy sector. Coordinator of the STEPS laboratory (Synergies of Thermochemical and Electrochemical Electrical Systems) of the Politecnico di Torino, and of the HySyLab and CO2 Circle Lab still of the Politecnico di Torino. Member of the Energy Center initiative of the Politecnico di Torino. Coordinator of 5 EU projects, and partner of around 20 EU projects, Coordinator of several national projects. In charge of strategic agreements between POLITO and SNAM, ENEL, SHELL, INNOENERGY. In charge of several projects with national and international companies. Member for Italy of ISO / TC 197 "Hydrogen Technologies" and of IEC-TC 105 "Fuel Cells".



### **Prof. Silvia Bodoardo**

Silvia Bodoardo is full professor at Politecnico di Torino where she is responsible for the task force on batteries, member of the Academic Senate, Director of the Study Center for the promotion of European Research for the Politecnico di Torino and former Vice President of EDISU- Body for the right to study of the Piedmont Region - and she leads the Electrochemistry Group@Polito. Her research activity is mainly focused on the study of materials for Li-ion and post Li-ion batteries. Her research is also dealing with cells production and battery testing. She is participating in several EU funded projects (coordinator of GIGAGREEN and STABLE EU projects) and also national and regional ones. She is leader of WP4 on Education in Battery2030+ initiative and is research chair in WG3 on advanced materials of BatterieEurope/Bepa and Leader of the Task Force on Education of BEPA (Battery Partnership). In March 2023 she was indicated as the first among the 20 Italian scientists who have revolutionized the world of research from [Wired](#). She has been designated for the writing of the new SETPlan of the European community

# DAY2: Advanced Technologies for Transport Decarbonization

## Highlights

### **Electrified Powertrains**

Prof. G. Rizzoni, The Ohio State University

This talk has been designed to provide a comprehensive introduction to powertrain electrification to automotive/mechanical engineers without significant prior exposure to the subject, with the aim of reviewing xEV technology and the challenges and opportunities associated with e-mobility.

### **Hydrogen fuel cells**

Prof. M. Santarelli, Politecnico di Torino

PEMFC fuel cells: cell and stack, thermodynamics and performance.

Basic structure of the PEMFC-based power system. Key system components and subsystems: air blower, H2 recirculation pump, humidifier. Thermal management. Sensors.

H2 storage system for automotive applications: gaseous, liquid, solid.

Notes on use of H2 in internal combustion engines.

Comparison with other defossilized powertrains.

### **Technical Visit: Battery Tech Center @ Stellantis**

### **Battery Electric**

Prof. S. Bodoardo, Politecnico di Torino

Introduction to the topic of batteries and current situation in Europe

Inside the cell: electrochemical processes, types of electrochemical cells

Characterization: important parameters for the characterization of cells

Cell production: processes for the production of lithium ion systems

Future technologies: solid state, conversion and post lithium ion systems

## Day 3 (March 14<sup>th</sup>): Putting it all together - lifecycle approaches, summary

Time	Topic	Speaker
9 a.m. – 10:30 a.m.	Renewable and E-Fuels	Prof. Andre Kulzer, Univ. of Stuttgart
10:30 a.m. – 11 a.m.	Coffee Break	
11 a.m. – 1 p.m.	Lifecycle analysis (LCA) + TCO	Dr. A. Elgowainy, Argonne National Lab
1 p.m. – 2:30 p.m.	Lunch Break	
2:30 – 4:00 p.m.	Hands-on GREET	Dr. A. Elgowainy, Argonne National Lab
4 p.m. – 4:30 p.m.	Coffee Break	
4:30 p.m. – 6 p.m.	Summary	Prof. F. Millo, A. Piano & Dr. Joshi



# DAY3: Putting it all together - lifecycle approaches, summary

## Speakers' Bios



### **Prof. André Casal Kulzer**

André Casal Kulzer is Professor at the Institute for Automotive Powertrain Systems, University of Stuttgart since January 2022.

Prof. Kulzer received a MSc. degree in Mechanical Engineering from Technical University of Lisbon in 1999 and a PhD degree from University of Stuttgart in 2004. For his PhD thesis he received the TR100 Award in 2004 from MIT's Technology Review - „one of the world's top young innovators under 35“.

After receiving his PhD he held the position of Senior Researcher and various Management positions at Robert Bosch GmbH in Schwieberdingen till 2011. From 2012 till 2021 he was Manager for Advanced Development Powertrain, together with Synthetic Fuels and Electrified Powertrain Concept Development at Dr. Ing. h.c. F. Porsche AG in Weissach. His actual mobility research interests range from electrification, hybridisation, batteries, combustion concepts, zero emissions, hydrogen, E-Fuels, powertrain systems virtual development, artificial intelligence and Life-Cycle-Analysis.



### **Dr. Amgad Elgowainy**

Dr. Amgad Elgowainy is a Distinguished Fellow, Senior Scientist, and leader of the Hydrogen, Electrification and Infrastructure Group at ANL, supervising over 35 PhD scientists and engineers. For over 20 years, he has led techno-economic, life cycle, and market analyses of alternative energy systems for various DOE programs. He developed the Hydrogen Delivery Scenario Analysis Model (HDSAM) and co-led the GREET life cycle analysis model, used by over 60,000 registered users worldwide.

Dr. Elgowainy co-lead modeling for DOE's H2@Scale initiative and contributed to DOE's OCED "Pathways to Commercial Liftoff: Clean Hydrogen" report. He serves as a technical expert in multiple U.S. hydrogen research teams and partnerships. Internationally, he represented the U.S. in IEA Annexes, the IPHE H2PA Task Force, and the ISO Technical Standard Committee on hydrogen emissions.

He received his PhD in 1994 from the State University of New York at Buffalo and is an inaugural member of the University of Michigan Hydrogen's External Advisory Board. He has earned 25 career awards, 7 patents, and has authored over 200 technical publications, including a book. In 2023, Stanford listed him among the top 2% most-cited scientists globally.



### **Dr. Ameya Joshi**

Dr. Ameya Joshi is an experienced technology leader with ~20 years of expertise providing strategic direction in transport decarbonization. He is the founder of MobilityNotes, an online platform which delivers unbiased information and consulting for all aspects of transport decarbonization.

He was previously the Vice President of Product & Strategic Partnerships at ClearFlame Engines and the Director of Emerging Technologies at Corning. He has nearly two decades of experience in the field of transport decarbonization and emissions control. Ameya delivered the Buckendale lecturer at SAE COMVEC in 2022, and serves on the Editorial Board of several SAE journals.

Ameya has a Ph.D. from the University of Delaware and pursued postdoctoral work in the field of fuel cells at the Colorado School of Mines.

# DAY3: Putting it all together - lifecycle approaches, summary

## Highlights

### **Sustainable Energy, Powertrain Solutions and the Role of E-Fuels**

Univ.-Prof. Dr.-Ing. André Casal Kulzer, University of Stuttgart

This keynote focusses on worldwide energy and sustainability considerations, incl. life-cycle analysis evaluation and comparison of various technologies among themselves considering the raw material usage, production phase, energy consumption and use phase. This comprises a complete life-cycle, with cradle-to-gate and well-to-wheel analysis. This will show that the world is not black and white and that one has to consider a holistic development and product impact perspective.

Afterwards, the efficiency and market success of these technologies can be analysed from various standpoints, company views and market results. A possible prognosis or scenario for the next decade is shown.

Finally, I would like to end the keynote with promising powertrain solutions for the future of mobility, looking into some details of these powertrains and also discussing the role of renewable lower-carbon or carbon-free fuels.

### **Life Cycle Analysis and Technoeconomic Analysis of Alternative On-road Fuel and Vehicle Systems**

Dr. Amgad Elgowainy, Argonne National Lab

This presentation will introduce the Greenhouse gases, Regulated Emissions and Energy use in Transportation (GREET®) model developed by Argonne National Laboratory for environmental life cycle analysis of alternative vehicle and fuel systems.

The presentation will compare the environmental performance of low-carbon fuel and vehicle systems, such as biofuels, e-fuels, hydrogen and plug-in battery electric vehicles, against conventional internal combustion engine vehicles powered by petroleum fuels.

The life cycle analysis will cover both fuel cycle and vehicle manufacturing cycle for various vehicle classes, such as light-duty, medium-duty and heavy-duty vehicle classes.

The presentation will also provide levelized cost of driving, in addition to life cycle greenhouse gas emissions of various fuel pathways and powertrain technology options.

The presentation will introduce publicly available tools for both technoeconomic analysis, e.g., HDSAM and HEVISAM for hydrogen delivery and fueling, and battery fast charging, and environmental life cycle analysis, e.g., GREET.