

# Opportunities and Challenges in Adopting Electro-fuels for Sustainable Transport

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## Abstract

Energy demand has been rising remarkably due to increasing population and urbanization. Without transportation by millions of personalized and mass transport vehicles based on IC engines, human civilization would not have reached contemporary living standards. Today, IC engines face many challenges related to fuel supply, energy efficiency, and emissions, requiring serious research efforts. At this stage of technology development, IC engine-based transportation and power generation systems depend on conventional fuels such as mineral diesel, gasoline etc., resulting in the rapid depletion of petroleum reserves. The application of different electro-fuels needs to be explored for sustainable development of the automotive sector and to combat global warming. Electro-fuels, also known as power-to-liquids (PtL), are synthetic fuels produced by using renewable electricity to convert carbon dioxide or hydrogen into a liquid fuel that can be used for transportation. Adopting electro-fuels offers promising opportunities to reduce greenhouse gas emissions, increase energy security, and promote sustainable transport. However, electro-fuels face several challenges: scalability, cost-effectiveness, and technical feasibility. This talk provides an overview of the opportunities and challenges of adopting electro-fuels for sustainable transport. The analysis suggests that electro-fuels have the potential to play a significant role in decarbonizing transportation, particularly in heavy-duty and long-distance transport. Still, their deployment will require a supportive policy framework, significant research and development investments, and stakeholder collaboration. Methanol and ammonia are emerging as strong electro-fuel candidates with the highest potential to significantly contribute to reducing crude oil dependence and environmental preservation. Methanol and ammonia can be used as a replacement for gasoline since they have a very high octane number and have been successfully used in many spark ignition (SI) engine applications. However, using methanol and ammonia in compression ignition (CI) engines remains challenging. Methanol and ammonia could be produced from several carbonaceous feedstocks such as natural gas, coal, biomass, and CO<sub>2</sub>. In this talk, I will discuss some of the challenges IC engines face in various sectors such as automotive, locomotive, marine, and several technical aspects of electro-fuels, underlining their potential to power the global economy in general and the transport sector in particular.

## Prof. Avinash Kumar Agarwal



Prof. Avinash Kumar Agarwal obtained his Undergraduate Degree in Mechanical Engineering (1994) from Malviya Regional Engineering College, Jaipur and his MTech (Energy, 1996) and PhD (Energy, 1999) from the Indian Institute of Technology (IIT) Delhi. After his Post-Doctoral Fellowship (1999 – 2001) at the ERC, UW, Madison, USA, he returned to India in 2001 and joined IIT Kanpur. He was a Visiting Professor at the University of Loughborough, UK; Photonics Institute, University of Vienna, Austria; Hanyang University and KAIST, South Korea. Prof. Agarwal is interested in research in IC engines, combustion, conventional and alternative fuels, Methanol/ DME/ Hydrogen/ HCNG fuelled engine development, LCA and TCO analyses, Fuel sprays, Lubricating oil tribology, optical diagnostics, laser ignition, HCCI, particulates and emission control, and large bore engines.

He has developed laser-fired hydrogen and CNG engines in automotive sizes and developed the first electronic fuel injection system equipped with a locomotive engine for Indian Railways. Currently, Prof. Agarwal is developing Methanol and DME-fuelled engines/ vehicles for the automotive/ agricultural sectors. Prof. Agarwal has published over 520 peer-reviewed international journal and conference papers, 63 edited books, and 129 book chapters, attracting 16000+ Scopus and 24000+ Google Scholar citations. Prof. Agarwal is the Editor of 'FUEL', Editor-in-Chief of the "Journal of Energy and Environmental Sustainability, Associate Editor of the ASME Journal of Energy Resources Technology, ASME Open Journal of Engineering, International Journal of Vehicle Systems Modelling and Testing, and the Journal of the Institute of Engineers (Series C) and an editorial board member of IMechE International Journal of Engine Research. He edited Wiley VCH, Germany's "Handbook of Combustion" (5 Volumes; 3168 pages), the most updated combustion compilation globally.

For his outstanding contributions, Prof. Agarwal is conferred upon **Sir J C Bose National Fellowship** (2019) by SERB, **SAE India Foundation GURU Award** (2022), **WSSET Innovation Award-2022**, Clarivate Analytics **India Citation Award-2017** in Engineering and Technology, Prestigious **Shanti Swarup Bhatnagar Prize (2016) in Engineering Sciences**, Rajib Goyal Prize in Physical Sciences (2015); **NASI-Reliance Industries Platinum Jubilee Award** (2012); INAE Silver Jubilee Young Engineer Award (2012); Dr C. V. Raman Young Teachers Award (2011); SAE Ralph R. Teetor Educational Award (2008); INSA Young Scientist Award (2007); UICT Young Scientist Award (2007); INAE Young Engineer Award (2005); Devendra Shukla Research Fellowship (2009-12), Poonam and Prabhu Goyal Endowed Chair Professorship (2013-16), SBI Endowed Chair Professorship (2018-21, 2022-25) at IIT Kanpur; AICTE Career Award for Young Teachers (2004); DST Young Scientist Award (2002); and DST BOYSCAST Fellowship (2002), in addition to inaugural version of **Distinguished Alumni Award-2021 by MNIT Jaipur and Distinguished Alumni Award-2022 by IIT Delhi**.

Prof. Agarwal is a highly cited researcher-2018 in and is among the top ten HCRs from India, among 4000 HCR researchers globally in 22 fields of enquiry. He is India's number one Energy researcher in the recently declared Stanford University listing of the top 2% of researchers globally. He is an elected **Fellow of the Society of Automotive Engineers** International, USA (SAE; 2012), **American Society of Mechanical Engineers** (ASME; 2013), Indian National Academy of Engineering (INAE; 2015), International Society for Energy, Environment and Sustainability (ISEES; 2016), Royal Society of Chemistry (RSC; 2018), National Academy of Science Allahabad (NASI; 2018), World Society of Sustainable Energy Technologies (WSSET-2020), **American Association for Advancement in Science** (AAAS; 2020) and **Combustion Institute USA** (CI; 2022). He is featured in the DST Golden Jubilee Coffee Table Book "**75 under 50 Scientists Shaping Today's INDIA**," released by Vigyan Prasar, Government of India, on National Science Day, February 28th, 2022. At IIT Kanpur, Prof. Agarwal has established a state-of-the-art "Engine Research Laboratory" ([www.iitk.ac.in/erl](http://www.iitk.ac.in/erl)), and he was also the founder-director of IIT Kanpur's Science and Technology Research Park (Technopark@iitk; <http://www.technoparkiiitk.com>). He also founded the International Society for Energy Environment and Sustainability ([www.isees.in](http://www.isees.in)) in 2014 and is the Editor of the Book Series Entitled "Energy Environment and Sustainability," published by Springer, Singapore (2016 onwards).