SAE INTERNATIONAL

SAE EDGE™
RESEARCH REPORT

Unsettled Issues Regarding Power Options for Decarbonized Commercial Vehicles

Jody E. Muelaner, PhD

SAE EDGE™
RESEARCH REPORT

Unsettled Issues Regarding Power Options for Decarbonized Commercial Vehicles

Jody E. Muelaner, PhD
Muelaner Engineering Ltd.

SAE INTERNATIONAL
Warrendale, Pennsylvania, USA

About the Publisher

SAE International® is a global association of more than 128,000 engineers and related technical experts in the aerospace, automotive, and commercial-vehicle industries. Our core competencies are lifelong learning and voluntary consensus standards development. Visit sae.org

SAE EDGE™ Research Report Disclaimer

SAE EDGE™ Research Reports focus on topics that are dynamic, in which knowledge is incomplete, and which have yet to be standardized. They represent the collective wisdom of a group of experts and serve as a practical guide to the reader in understanding unsettled subject matter. They are not meant to provide a recommended practice or protocol. The experts have assembled as a community of practitioners to contribute and collectivize their thoughts and points of view; these are not the positions of the institutions or businesses with which they are affiliated, nor is one contributor's perspective advanced over others. SAE EDGE™ Research Reports are the property of SAE International and SAE alone is responsible for their content.

About This Publication

SAE EDGE™ Research Reports provide state-of-the-art and state-of-the-industry examinations of the most significant topics in mobility engineering. SAE EDGE™ contributors are experts from research, academia, and industry who have come together to explore and define the most critical advancements, challenges, and future direction in areas such as vehicle automation, unmanned aircraft, cybersecurity, advanced propulsion, advanced manufacturing, Internet of Things, and connectivity.

Related Resources

SAE EDGE™ Research Report: Unsettled Issues in Electrical Demand for Automotive Electrification Pathways by Jody E. Muelaner, PhD
https://saemobilus.sae.org/content/EPR2021004/

SAE Team

Frank Menchaca, Chief Growth Officer
Michael Thompson, Director of Standards, Information and Research Publications
Monica Nogueira, Director of Content Acquisition
Beth Ann Dibeler, Product Manager
William Kucinski, Managing Technical Editor

EPR2021021
ISSN 2640-3536
e-ISSN 2640-3544
ISBN 978-1-4686-0270-5

To purchase bulk quantities, please contact: SAE Customer Service

E-mail: CustomerService@sae.org
Phone: 877-606-7323 (*inside USA and Canada*)
+1-724-776-4970 (*outside USA*)
Fax: +1-724-776-0790

https://www.sae.org/publications/edge-research-reports

About the Editor

Dr. Jody E. Muelaner is a chartered mechanical engineer with a background in metrology, aerospace manufacturing, and machine design. He now specializes in writing about technical topics in a way that the target audience can easily understand.

His writing has included technical reports for Rolls-Royce and Airbus, peer-reviewed journals, UK Government reports, as well as magazines and websites. He has published several hundred articles and received the Sage Best Paper Award in 2010.

Starting out in machine design, Dr. Muelaner initially worked on sawmills, waste processing machinery, domestic appliances, and medical devices. After moving into metrology, his research focused on modeling and optimizing uncertainty in manufacturing systems, enabling right-first-time assembly, and the design of innovative laser instruments. He founded Muelaner Engineering Ltd. in 2018 to provide consultancy and technical writing services within advanced manufacturing and sustainable transport. Dr. Muelaner lives with his family in Bristol.

contents

Unsettled Issues Regarding Power Options for Decarbonized Commercial Vehicles

Abstract

Direct electrification appears to provide the most cost-effective route to decarbonization of commercial vehicles across the vast majority of duty cycles. However, uptake may be constrained by critical metal supply. An electric road system (ERS) could offer a highly efficient and cost-effective route to direct electrification and greatly reduce the volume of batteries required. Pilot schemes are urgently needed to provide concrete data on operating costs for different ERS technologies. Techno-economic studies should compare different vehicle configurations operating within an ERS with varying levels of coverage.

It will be many years before existing industrial uses of hydrogen have been decarbonized. Investments in hydrogen should be focused on decarbonizing existing (non-transport) applications before establishing new markets and committing infrastructure to new end-use technologies. It remains highly uncertain whether renewable hydrogen will ever be able to compete economically with direct electrification. There are also multiple potential pathways for renewable hydrogen to supply energy for road transport, including buffering electrical supply within the grid, in hydrogen or methanol fuel cell vehicles, and in methanol or e-diesel internal combustion engine (ICE) vehicles. Only one of these pathways would require a hydrogen refueling infrastructure, which must, therefore, be considered a highly risky investment.

There is limited scope to increase biofuel production sufficiently for widespread transport use, and "electrofuels" are likely the most expensive route to decarbonization of road transport. However, where plug-in hybrid electric vehicles (PHEVs) obtain most of their power from an ERS, liquid biofuels and electrofuels could be useful for occasional off-grid range extension. To achieve extremely long-range operation in remote locations, liquid fuels remain the only viable option.

Further analysis is required to understand the lifecycle energy use for different options. Conventional vehicles require the least energy to manufacture, but electrofuels cost the most energy to synthesize. Battery vehicles have very high energy efficiency that can compensate for their relatively high embedded energy of manufacture in a relatively short time period. Hydrogen fuel cell vehicles combine extremely high embedded energy with only moderately higher efficiency compared to electrofuels, making it unclear whether they actually offer improved energy efficiency in use.

NOTE: SAE EDGE™ Research Reports are intended to identify and illuminate key issues in emerging, but still unsettled, technologies of interest to the mobility industry. The goal of SAE EDGE™ Research Reports is to stimulate discussion and work in the hope of promoting and speeding resolution of identified issues. SAE EDGE™ Research Reports are not intended to resolve the challenges they identify or close any topic to further scrutiny.

JODY E. MUELANER, PhD
Muelaner Engineering Ltd.

EDGE Development Team

Greg Archer, *European Federation for Transport and Environment*
Bart Kolodziejczyk, PhD, *Fortescue Metals Group Ltd*
Prof. Öivind Andersson, PhD, *Lund University*
Sebastian Verhelst, PhD, *Lund University*
Paul Miles, *Sandia National Laboratories*
Prof. James Turner, PhD, *King Abdullah University of Science and Technology*
Christer Thorén, *Scania Group*
Alan Malby, *Concept2Customer Ltd*

ISSN 2640-3536