In this issue, we examine the transportation sector’s progress toward zero emission fuels, buses, ships, and airplanes.
The United Nations Framework Convention on Climate Change (UNFCCC) Paris Agreement (https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement) aims to limit global temperature rise to well below 2 °C and to pursue efforts to limit it to 1.5 °C to mitigate the worst impacts of climate change. The Intergovernmental Panel on Climate Change’s (IPCC) Special Report (https://www.ipcc.ch/sr15/) on global warming of 1.5 °C explains that the likelihood of ice-free summers in the Arctic is once per century under 1.5 degrees of warming, but once per decade at 2 degrees. Similarly, the IPCC estimates that coral reefs would decline 70–90% under 1.5 degrees of warming, which is worrying enough, but at 2 degrees, more than 99% would be lost. As of July 2020, the world is already approximately 1.3 degrees warmer than the pre-industrial era, according to Columbia University (http://www.columbia.edu/~mhs119/Temperature).

Limiting warming to 1.5 °C with little or no overshoot requires human-caused carbon dioxide emissions to fall by about 45% from 2010 levels by 2030 and to reach net zero emissions around 2050, according to the IPCC. All sectors must decarbonize if the world is to achieve the Paris Agreement temperature goals, including the global transportation sector, which represents about one quarter of anthropogenic carbon dioxide emissions, according to current estimates released by the International Energy Agency (https://webstore.iea.org/co2-emissions-from-fuel-combustion-2019-highlights).

In the articles that follow, the authors look at the transportation sector's progress toward zero emission fuels and vehicles.

In the first article, Yuanrong Zhou explains that not all transportation fuels are created equally. While some fuels, especially those derived from wastes, reduce lifecycle greenhouse gas emissions compared to fossil fuels, others, including those made from palm oil, actually increase total emissions. In short: the feedstock matters.

Next, Mike Nicholas explains that while electric passenger vehicles are becoming less expensive and electric vehicle (EV) sales are growing, half of Americans would not be able to conveniently recharge an EV at home. Subsidized public charging infrastructure could bridge the gap and remove barriers to EV ownership, he argues.

In the third article, Yihao Xie tells us about the rise of zero emission buses. He explains that cities are replacing old, inefficient buses with new zero emission electric buses that eliminate tailpipe emissions and improve air quality. Chinese cities, as well as Los Angeles, Paris, Santiago, and Bogotá, are at the forefront of the zero emission bus revolution. Fleet renewal is expensive, however, so stimulus spending as part of governments’ green recovery efforts to address the coronavirus pandemic could be a source of funding.

Fourth, Gavin Allwright explains how the global maritime shipping industry is returning to wind power to reduce fuel consumption and emissions. While most commercial ships won’t be fully powered by the wind, many can be retrofitted with rotor sails, rigid sails, or even soft sails or kites. Wind power, together with route optimization, better ship designs, and low- and zero emissions fuels can help ships meet the International Maritime Organization's goal of cutting emissions from the sector by at least 50% from 2008 levels by 2050 and, eventually, eliminating emissions altogether.

Lastly, Dale Hall tells us how airplanes could become zero emission. Aviation is particularly difficult to decarbonize because fuels need to be energy-dense and lightweight. Hydrogen fuel cells paired with advanced batteries could do the trick, but whatever energy source is used, it needs to be powerful enough to generate the thrust needed to keep planes in the air. Substantial investment in research and development will be needed to get large-scale, zero emission planes off the ground. In the meantime, improving the efficiency of existing aircraft through lightweight materials and operational strategies like maximizing belly freight can cut emissions from conventional aircraft.

We thank the authors for their important contributions to this discussion and hope you enjoy learning more about the transition to zero emission transportation and its role in achieving society's climate goals.

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