MIT CLIMATE GRAND CHALLENGES

Massachusetts Institute of Technology

Rapid Decarbonization of Freight Mobility

Freight mobility is one of the building blocks of our economies and a key enabler of economic growth as well as social and technological progress. In the United States alone, the freight and logistics market reached $1.6 trillion USD in 2018 and accounted for about 8% of total GDP. Globally, the logistics market in 2018 was worth over $6.5 trillion USD.

At the same time, the freight transportation and logistics industry is one of the fastest growing sources of global greenhouse gas (GHG) emissions. Global GHG emissions from freight transportation are projected to reach around 8.1Gt CO_2eq per year by 2050, roughly four times the amount emitted in 2010.

However, freight transportation is one of the hardest sectors to decarbonize because:

1. the demand for freight transportation is expected to grow rapidly in the coming decades;
2. the sector is inherently complex and fragmented;
3. changing transportation systems is time and capital intensive; and
4. emission-free long-distance transportation technologies have not yet reached technological maturity to enable large-scale deployment.

Given these challenges, the five research thrusts proposed by this white paper are set to devise a comprehensive set of freight transportation interventions and policy recommendations that collectively yield the required emission reductions to attain carbon neutrality of global freight transport by 2050.

KEY OBJECTIVES

1. We provide clear guidance for transitioning towards carbon-neutral transportation assets, including infrastructure and vehicle technologies.
2. We promote a paradigm-shift for low-carbon supply chain design, planning, and operation.
3. We employ a systems perspective to capture synergies and incorporate feedback loops with adjacent socio-technical systems such as people mobility.
4. We test, validate, and refine a set of proposed decarbonization policies and interventions through real-world pilot implementations with major industry and policy partners.
5. The economic viability and readiness for widescale implementation of the proposed decarbonization measures are at the heart of our research.

RESEARCH THRUSTS

The five proposed research thrusts cover the entire freight transportation value chain and provide guidance and insights on the technological, operational, and managerial levels.

1. Tackling the hard-to-abate middle-mile transportation modes

We will conduct an end-to-end review and evaluation of current and future propulsion technologies for middle-mile (i.e., long-distance) transportation of goods, and provide clear guidance on a fruitful and economically viable trajectory of deployment of these technologies.

2. Avoiding transportation through better supply chain design and planning

We will present a suite of data-driven tools and analytical methods to design and reconfigure supply chains with the objective of minimizing their carbon footprint, while remaining cost-competitive and providing the desired levels of service.

3. Emission mitigation in first-mile, last-mile, and returns and disposal logistics

We will investigate emission mitigation strategies through novel delivery models and business operations to provide near-term decarbonization of local and regional freight mobility.

4. Co-benefits and synergies with people mobility

We will develop interventions aimed at the system-level optimization of integrated passenger and freight flows.

5. Knock-on effects across other economic sectors

We will integrate the previous research thrusts and assess the resulting knock-on effects for the carbon footprint and other sustainability dimensions across all economic sectors and global regions.

SCOPE

Throughout the first half of the proposed project, we will develop a detailed technically, operationally, and commercially viable roadmap toward carbon neutral freight transportation. This roadmap will guide pilot implementations with global industry and policy partners to test, evaluate, validate, and refine the proposed policies and interventions throughout the second half of the project. The refined and evaluated set of interventions, as well as guidance to support their successful widespread implementation, will be documented in a comprehensive final project report.

TEAM

Given the complexity of freight mobility systems and the challenges ahead, each research thrust requires input from various domains across and beyond MIT. The MIT Center for Transportation and Logistics (CTL) will take the lead on this research effort, coordinating an interdisciplinary team of researchers across Civil and Environmental Engineering, Urban Studies and Planning, Transportation, and Energy Economics. In this effort, MIT CTL can rely

on decades of experience in working with leading industry players and policy makers on practice-oriented research and subsequent pilot implementations.

By mobilizing a critical mass of industry players and policy partners, we will stimulate industry-wide adoption of proven and successful measures for transitioning to carbon-neutral freight transportation, thereby contributing to a significant reduction of carbon emissions and accelerated progress in this hard-to-abate sector. The goal is to get a multitude of actors and disciplines to collaborate to transform the entire freight transportation industry