Locomation

Trucking Freight Transportation Industry

BOUNDLESS
IMPACT RESEARCH & ANALYTICS

Environmental Impact Report
November 2021
Company Description

Locomation was founded in 2018 by a team of experts on autonomous vehicles, robotics, and artificial intelligence from Carnegie Mellon’s National Robotics Engineering Center and trucking industry leaders with experience in transportation logistics. Locomation’s freight optimization services were developed to deliver safe autonomous solutions such as two-truck convoys. This solution can increase operating margins and utilization of trucks, while reducing fuel consumption and emissions.

- Headquarters: Pittsburgh, Pennsylvania
- Founded: 2018
- Business model: Delaware C-Corp
- Employees: Around 80
- Intellectual property: 1 issued patent
- Website: https://locomation.ai/

Alignment with the United Nations’ Sustainable Development Goals

- Good Health and Well-being
- Industry, Innovation and Infrastructure
- Responsible Consumption and Production
- Climate Action

Climate Impact Score: 10/10

1 - Worst  Per Unit Impact  10 - Best

Boundless Analysis

- This assessment compares Locomation’s Autonomous Relay Convoy™ (ARC) technology against other fuel reduction technologies such as cooperative adaptive cruise control (CACC) and idle reduction technology (IRT).
- The Climate Impact Score is based on per tonne-kilometer impact for key performance indicators, including Greenhouse Gas (GHG) Footprint, Photochemical Ozone Formation, Fossil Fuel Energy Footprint, Operating Cost, and GHG Abatement Cost.
- Boundless scores Locomation 10/10 on per-unit impact, considering predeployment information provided by Locomation.
- Measured per tonne-kilometer, Locomation’s technology is estimated to reduce the GHG Footprint of a class 8 truck by approximately 22%.
- Based on information provided by Locomation, its ARC technology can reduce idling by up to 90% and increase fuel efficiency by 8% on average, resulting in a lower GHG Footprint and Operating Cost than a traditional class 8 truck.
- Considering assumptions provided by Locomation, it was estimated that its technology can reduce GHG emissions while also being cost competitive.
Management Team

- Dr. Çetin Meriçli, Co-Founder, CEO, was formerly Special Faculty at the National Robotics Engineering Center (NREC) of Carnegie Mellon's Robotics Institute. He has 20 years of experience in developing and deploying complex robotic systems for real world applications. He was a Postdoctoral Fellow in the Computer Science Department at Carnegie Mellon University prior to joining NREC.

- Dr. Tekin Meriçli, Co-Founder, CTO, was formerly Special Faculty / Commercialization Specialist at NREC within Carnegie Mellon’s Robotics Institute, where he initially joined as a Senior Robotics Engineer. Prior to joining NREC as full-time staff, he was a Postdoctoral Fellow at the Human-Computer Interaction Institute at Carnegie Mellon University.

Technology

- The Locomation solution consists of two-truck convoys with a lead truck and a follower truck and two drivers. Both trucks are equipped with Locomation’s ARC system and are electronically tethered to move together. The Human-Guided Autonomy™ solution enables one driver to operate the lead truck while a second driver rests in the follower truck, and periodically, the trucks swap places to allow each driver to take turns leading and resting.

- Locomation seeks to enable carriers to safely operate two trucks between 20 and 22 hours a day, delivering double the cargo, faster, and twice the distance.

- Locomation’s system also offers custom route optimization services based on its proprietary analysis of the U.S. interstate highway network. Locomation customers can select routes that maximize operational efficiency.

Operations and Partnerships

- Locomation’s headquarters is located in Pittsburgh, Pennsylvania.

- Locomation assists trucking industry groups, regulators, and insurance companies in defining new regulations and safety and risk management strategies that take into account full autonomy.

- Locomation has partnered with Cummins Inc., ZF Friedrichshafen AGZF, Rush Enterprises Inc., PGT Trucking Inc., and Wilson Logistics Inc.
Environmental Highlights

Summarized below are the most relevant impact categories and codes that refer to the United Nations’ Sustainable Development Goals (SDGs). The present section highlights the most important factors that explain how this technology impacts the environment and society.

**Climate Action**

The operation of a truck using Locomation’s ARC system has a lower GHG Footprint per tonne-kilometer than a traditional class 8 truck without the system. The GHG Footprint of a truck using Locomation’s system is estimated to be 0.054 kilograms (kg) of carbon dioxide equivalent (CO$_2$e) per tonne-kilometer (tkm). On average, a truck using Locomation’s system has a GHG Footprint approximately 22% lower than a traditional truck and 18% lower than a truck using a CACC or IRT system. Savings are driven primarily by an increase in fuel efficiency and reduction in idling time. Note that this analysis uses the 100-year global warming potential.

Relevant code: **SDG 13**, Climate Action

**Good Health and Well-Being**

High levels of ground-level ozone can irritate the respiratory system, aggravating asthma and other lung diseases such as emphysema and bronchitis. Ground-level ozone, also called photochemical ozone, is created through the interactions of volatile organic compounds (VOCs) and nitrogen oxides (NOx) in the presence of heat and sunlight$^1$. The combustion of fossil fuels is a major contributor to these emissions that react with the sun’s ultraviolet light to form ground-level ozone. Locomation’s system, by reducing the use of fuel combusted by trucks, can reduce Photochemical Ozone Formation by 22% compared to a traditional class 8 truck.

Relevant code: **SDG 3**, Good Health and Well-Being

**Industry, Innovation and Infrastructure & Sustainable Consumption and Production**

Locomation’s ARC system can increase the resource-use efficiency of freight trucking by optimizing the fuel economy and utilization rate of trucks, and reducing the empty miles traveled by trucks. These improvements would result in lower costs, reduced GHG and air pollution emissions, and a lower required number of trucks in a fleet to deliver the same transportation service. Compared to the trucking freight transportation industry benchmark, Locomation’s ARC system represents a cleaner and more environmentally sound technology.

Relevant code: **SDG 9**, Industry, Innovation and Infrastructure; **SDG 12**, Sustainable Consumption and Production

---

Benchmarking and Conclusions

Locomation claims its ARC system could improve a truck’s fuel efficiency by 8% and reduce idle time by 90%. Considering this, Locomation’s system has the potential to significantly improve the environmental and financial performance of a truck on the road. The biggest contributor to the GHG Footprint of a class 8 truck is the combustion of fuel, which represents 81% of the total GHG Footprint. The Locomation system, due to its fuel efficiency and idle improvement potential, could reduce the GHG Footprint of a truck by approximately 22% per tkm. The fuel use reduction also translates into an Operating Cost that is 19% lower than for a traditional truck. Locomation enables lower GHG Footprint and lower Operating Cost, meaning that the technology can reduce GHG emissions while also being cost competitive.

The Fossil Fuel Energy Footprint of a truck using Locomation’s system is 21% lower than that of a traditional truck, 16% lower than a truck with a CACC system, and 15% lower than a truck with an IRT system. This reduction in the use of fossil fuels also translates into a reduction of 22% in Photochemical Ozone Formation compared to a traditional truck.

Boundless engaged an experienced environmental engineer with a PhD in Sustainable Transportation to review the Locomation assessment and validate the assumptions made in calculating the Environmental Key Performance Indicators (EKPIs). The expert concluded that the hybrid approach taken by Boundless, a combination of process-based life cycle assessment (LCA) and economic input-output LCA, increased the robustness of the LCA of Locomation’s technology and that the increased efficiencies reported by Locomation are consistent with the reported results from other studies in the literature and industry reports.
Environmental Key Performance Indicators

Boundless evaluated the life cycle inputs and impacts per tonne-kilometer for a class 8 truck with Locomation’s ARC system, considering the ARC system manufacturing and the truck’s fuel use, maintenance, and operation. EKPI results for Locomation are compared to a traditional class 8 truck, a class 8 truck with a CACC system, and a class 8 truck with IRT implemented.

GHG Footprint
This metric represents the GHG emissions reported in kg of carbon dioxide equivalent (CO₂e) per tkm.

- The estimated GHG Footprint of a long-haul class 8 truck with a 20-ton payload using Locomation’s ARC technology is 0.072 kg of CO₂e per tkm.
- It was estimated that Locomation’s system can reduce the GHG Footprint of a class 8 truck by approximately 22% per tkm.
- The majority of the GHG Footprint for the four systems assessed, 80% on average, is attributed to the combustion of fuel during movement or idling. Emissions due to idling represent 6.5% of the total emissions of a conventional class 8 truck.
- Considering the information provided by Locomation regarding the improvements its technology can bring to idling and over-the-road operations, Boundless estimated that the emissions per tkm associated with idling can be reduced by 97% and the emissions that occur while driving can be reduced by 16%.

GHG Abatement Cost
This metric represents the minimum price on GHG emissions that would enable the subject technology to reach cost parity with the existing industry baseline technology, and it is presented in dollars per tonne of avoided GHG emissions (CO₂e). A negative value would signify that the technology is estimated to be cost competitive with the baseline technology even in the absence of a price on GHG emissions.

- The estimated GHG Abatement Cost of the Locomation system is ~$0.68 per kg of CO₂e abatement. Considering assumptions provided by Locomation, it was estimated that its technology can reduce GHG emissions while also being cost competitive.
- Installing an IRT system also presents a cost-competitive alternative to reduce GHG emissions. CACC technology, although it can reduce GHG emissions, is more expensive to implement.
EKPIs continued
This section presents a description of continued EKPIs addressed and a review of Locomation’s environmental performance relative to its competition.

Operating Costs
This metric measures the cost of transporting 1 tonne of goods a distance of 1 kilometer.

- The Operating Cost of a truck using Locomation’s ARC system was estimated as $0.06 per tkm. Locomation’s Operating Cost represents a 19% reduction compared to a traditional class 8 truck.
- It was estimated that installing an CACC system could increase Operating Cost 1.28% on average, while installing an IRT system could lower the Operating Cost 1.1% on average.

Photochemical Ozone Formation
A measure of NOx and non-methane volatile organic compounds (NMVOCs) that react with sunlight and produce ozone, per 1 tonne of goods transported a distance of 1 kilometer. Measured as a kg of ozone ($O_3$) equivalent per tkm.

- The Photochemical Ozone Formation of a truck with Locomation’s system was estimated as 2 kg of $O_3$ per tkm, 22% lower on average than a traditional class 8 truck.
- It was estimated that using a CACC system can reduce Photochemical Ozone Formation by 5% and installing an IRT system can reduce it by 6%, both compared to a traditional class 8 truck.

Fossil Fuel Energy Footprint
This metric represents the fossil fuel energy inputs per tkm, including the operation and embodied energy of materials.

- The estimated Fossil Fuel Energy Footprint of a truck with Locomation’s system is 1.52 megajoules (MJ) of fossil energy per tkm.
- The Fossil Fuel Energy Footprint of a truck with Locomation’s system is 21% lower than that of the traditional class 8 truck, 6% lower than a truck with a CACC system, and 6% lower than a truck with an IRT system.
About Boundless Impact Research & Analytics

Boundless Impact Research & Analytics is a market intelligence and impact analytics firm that provides quantitative and evidence-based research and data for investors, companies, and funds. Driven by the latest research from independent industry and academic experts, Boundless Impact Research & Analytics offers analysis, market trends, and evidence of best practices in a growing number of emerging sectors that address significant environmental and health challenges. Our research into emerging technologies, impact assessment of companies, and thought leadership provide investors with the latest and most relevant information to drive their investment decisions.

Contact Us

Boundless Impact Research & Analytics
www.boundlessimpact.net
Michele Demers, CEO and Founder
mdemers@boundlessimpact.net

The information provided in this report by Boundless Impact Research & Analytics and accompanying material is for informational purposes only. The information in this report should not be considered legal or financial advice, nor an offer to buy or sell or a solicitation of an offer to buy or sell any security, product, service, or investment. Boundless Impact Research & Analytics does not make any guarantee or other promise, representation, or warranty as to the accuracy or completeness of the statements of fact contained within, or any results that may be obtained from using our content. Neither this content, nor the investment examples cited, should be used to make any investment decision without first consulting one’s own financial advisor and conducting one’s own research and due diligence. To the maximum extent permitted by law, Boundless Impact Research & Analytics disclaims any and all liability in the event any information, commentary, analysis, opinions, advice, and/or recommendations prove to be inaccurate, incomplete, or unreliable, or result in any investment or other losses.