



# SAMPLE

## DRIVING AUTOMATION

COMMERCIAL TRANSPORTATION'S PURSUIT OF  
LEVEL 4 AUTONOMY

2019 LAWRENCE R. KLEIN BLUE CHIP AWARD WINNER

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# 1 - EXECUTIVE SUMMARY

## DRIVING AUTOMATION COMMERCIAL TRANSPORTATION'S PURSUIT OF LEVEL 4 AUTONOMY

## EXECUTIVE SUMMARY

The ACT Research team has spent the last nine months in an extensive research effort into the prospects for SAE Level 4 autonomous commercial vehicle adoption over the next eighteen years, complete to calendar year 2040. ACT has been gaining experience and knowledge investigating the impact of new technologies for commercial vehicles over the past decade, starting with a multi-client study in 2011-2012 on the potential of natural-gas powered engines to replace diesel in some commercial vehicle segments. Over the course of the ensuing ten years, ACT Research has completed a number of studies on natural gas as well as adoption of Commercial Electric Vehicles, with our most recent study released in December 2021 - "Powering Up" - focused on the Global Commercial Electric Vehicle market.

Over the course of the past year, we have frequently been asked, "when are you going to do a market penetration study on driverless autonomous vehicles?" From that customer need we launched this study in Q1 2022. The scope of this study is to provide a comprehensive look at the key factors influencing adoption of SAE Level 4 autonomous commercial vehicles (ACV) and the resultant adoption growth across a number of commercial vehicle applications.

One will note that all of ACT's new technology-focused studies have been done in a multi-client format. We continue to believe, and the results have proven, that in bringing disparate stakeholders together, better insights can be derived. Bearing this notion out, the benefits of conducting these studies in a multi-client format have provided invaluable feedback, as inputs from a variety of industry sources build a more complete picture which in turn raises better questions.

In contrast to the timeline of commercial electric vehicles which are available in today's market, SAE Level 4 autonomous commercial vehicles are still, for the most part, in pre-production stages. Current activity is focused on limited field testing and pilot runs taking place in the sunbelt states (primarily Texas), providing feedback for additional product development, while simultaneously helping to educate and inform stakeholders and the general public about autonomous vehicles (AV). The majority of AV Systems providers focused on commercial vehicles have been established in the past six to seven years, with the exception of the few that found their starts earlier, but in adjacent vehicle markets. Legacy OEMs have been announcing partnerships with selected AV system providers since early 2019, providing legitimacy to the concept that autonomous trucks are more than just a speculative science project, but will have a reliable path to becoming a viable solution. It should be noted that not all AV Systems suppliers have opted to partner with an OEM, as some are adopting the strategy of being OEM-agnostic. In addition to the alignment of AV systems suppliers with OEMs, the past few years have seen a significant amount of activity between autonomous companies and commercial vehicle fleets and logistic suppliers.

While the bulk of the ACV market activity has been focused on freight hauling and long-haul Class 8 tractor-trailers combination applications, there are companies that have instead chosen to initially focus on straight truck, last-mile freight distribution and delivery space, while others have focused on moving people in autonomous transit and shuttle bus applications. As a final subset, there are also firms that have developed vehicles that completely eliminate the cab/human interface and operate as “pods” shuttling trailers within distribution centers.

As we have mentioned in our previous studies, the purchase of a commercial vehicle, in contrast to most passenger vehicle purchases, is not a “life-style” purchase for the buyer, but a business decision. This is true not only with for-profit businesses, but also non-profits and governmental agencies who purchase vehicles based on total cost of ownership (TCO) financial considerations. Recognizing that most commercial vehicles are working in competitive situations, questions surrounding operating costs are fundamental for commercial buyers and are at the heart of ACT’s market-sizing methodology in this multi-client build-up of knowledge.

Our study’s findings are that autonomous commercial vehicles can offer a better ROI than traditional “driver-in” vehicles, dependent of course on each application’s unique duty cycle. SAE Level 4 autonomous commercial vehicles are forecasted to see reasonable share adoption growth, particularly in the next decade as Operational Design Domain (ODD) constraints are eliminated and the technology develops over the timeframe of this study.

Before one can analyze adoption based on financial TCO/ROI analysis, the available market needs to be defined. The feasibility of deployment of SAE Level 4 autonomous commercial vehicles depends on both regulations that allow such operations, as well as the specific ODD of the AV system which may or may not restrict operations to specific types of roadways, weather, or other driving conditions. A thorough review and discussion of regulations impacting ACVs can be found in Section 6.

ACT has developed a very measured and methodical approach to analyzing these exogenous considerations and restraints, which has resulted in a stratified depiction of the elements that define the size of the Total Available Market (TAM). As a result, the TAM changes over the timeframe of the study, as regulations are forecasted to change, and the AV systems technology is also predicted to change, expanding the ODD. Section 3 of the report, Total Available Market, discusses the methodology in detail. It should be noted that the underlying basis for defining the market has been developed using vehicle miles travelled (VMT) to size the various market layers. Those details, combined with the ACT Research Used Truck database (derived from a million-plus transactions including vehicle ages and odometer readings) provide a basis for defining ACV new truck sales/builds.

Adoption rates are applied to the TAM, based on the financial analysis derived from our TCO models, detailed for each unique vehicle application. The analysis includes detailed TCO models for freight hauling applications for both private and for-hire fleets, and includes hub-to-hub routes as well as end-to-end routes for five individual freight hauling vehicle applications in addition to two vocational vehicle applications, and transit bus.

The TCO models driving the study's conclusions have been developed using a "bottom-up" approach by disaggregating commercial vehicle markets. From there the model(s) consider AV system suite hardware & software component costs, vehicle redundancy costs that enable SAE Level 4 full driver-out, operational costs based on duty cycles, fuel costs, maintenance costs, insurance, and more. They also factor in costs for supporting infrastructure. The TCO models generate two key financial measures: payback period and total lifetime cost savings, comparing autonomous vehicle alternatives (SAE level 4 driver-out) against incumbent traditional vehicles operated by human drivers. The financial analysis is based on analyzing incremental costs for the autonomous systems and vehicle redundancy requirements - utilizing a diesel powertrain - coupled with resultant operating margins. We do recognize that in the later years of this study - based on the results of ACT's CEV 2021 studies "Charging Forward" and Power UP!" - that battery-electric powertrains will replace diesel in many use cases, even for Class 8 tractors. To keep a simple apples-to-apples comparison, we have opted to analyze the TCO using a diesel powertrain for a consistent, conservative approach.

ACT Research has developed a proprietary algorithm that converts these financial metrics into share points to derive adoption rates. The costs associated with ACVs will fall over time, thanks to rising volumes and continuous technology improvements, while incumbent traditional driver-in vehicle markets will continue to face driver recruiting challenges that will be exacerbated through the forecast period by low population growth. The impact of these two dynamics results in rising market shares for autonomous vehicles throughout the forecast period.

A study on ACV adoption would not be complete without research and discussion on pertinent industry standards governing autonomous vehicles. Section 10 encompasses a review of the Autonomous Commercial Vehicle Safety Standards containing a thorough review of the various UL, ISO, ANSI, SAE, and UNECE standards that ensure safety and reliability of autonomous commercial vehicles.

Infrastructure to support ACVs, and in particular hub-to-hub operations, are reviewed in Section 8. Our study findings show that the concept of transfer hubs is still in very early planning stages, with some uncertainty as to ownership of such transfer hubs, and whether they will be public, or private facilities, or some mix. Already there has been some activity with real estate developers acquiring properties on the outskirts of major freight markets as they bet on an autonomous future in that large market niche.

A driving force behind the concept of adopting autonomy to commercial vehicles has been both inherent safety benefits, as well as addressing the decline in available drivers to fulfill trucking needs, especially long-haul routes. Section 9 includes a very comprehensive review of driver impact and considerations. The conclusion is that the industry will see a shift from long-haul to local driving jobs as well as the growth of new jobs to support autonomous freight, and while there will be contraction in long-haul truck driving jobs, virtually all the of the takeout will be through attrition and retirements.

This study includes both fast and slow adoption scenarios, in addition to a baseline adoption forecast which we believe is the likeliest scenario. We have included scenario analysis in the appendix, as this approach enables one to understand how adoption rates would change relative to our baseline assumptions.

It should be noted that autonomous driving systems for commercial vehicles are still in the development and piloting stages of implementation. Our baseline forecast pegs the earliest SOP for commercial introduction of SAE Level 4 driver-out autonomy for commercial vehicles will not happen until 2025, nearly two years from now, and will be initially limited to a number of freight corridors. This is an “emerging” technology, compared to other innovations that are happening today. Is the technology capable? The findings from our study confirm yes, the technology can be capable for SAE Level 4. Industry participants from all aspects, OEMs, AV service providers, fleets, and logistics providers have indicated that the roll-out of SAE Level 4 commercial vehicles will be achieved through a very measured and careful approach.

The body of work you will find in the write-up that follows, and the corresponding Excel files containing the TAM and TCO models at the heart of our conclusions, reflect countless hours of research and analysis by the ACT team, and the many meetings and discussions with the study’s participants. Those discussions were forthright, informative, interesting, and enjoyable. They have both built upon longstanding relationships that ACT Research has formed with our customers over the years, as well as created newfound relationships with many of the AV systems suppliers that have joined our world of commercial vehicles. As we have found from this, as well as our past multi-client studies, it takes a team, and we thank those who joined our ACV team over these past months. We look forward to continuing our analytical work on autonomous commercial vehicle adoption, and are excited to see how our industry will evolve over the coming years.