Sensata Technologies

ELECTRIFICATION AND DESIGN INNOVATIONS DRIVING EVOLUTION IN LIFT TRUCKS AND MEWPS

WHITE PAPER

Over the past 15 years, perhaps no industry has seen such dynamic changes than material handling – fueled by the massive shifts in vehicle architecture, regulatory frameworks, and ecommerce and warehouse dynamics.

Those changes have altered the profile of lift trucks and mobile elevated work platforms (MEWPs) and paved the way for significant changes in how equipment operates on a daily basis.

WIDE-REACHING MEGATREND IMPACTS

eCommerce

The changes driven by Amazon and other ecommerce players have fueled rapid expansions and changes within the warehousing and material handling space, putting a consistent focus on throughput and speed to delivery.

Putting the rapid expansion in recent years in perspective - From 1997 through 2009, Amazon never added more than approximately 4 million square feet of fulfillment space. From 2016 through 2019, it added at least 23 million annually. And from the end of 2019 to the end of 2021, its global fulfillment network nearly doubled from 272 million square feet to 525 million.

ANSI Regulations for MEWPs

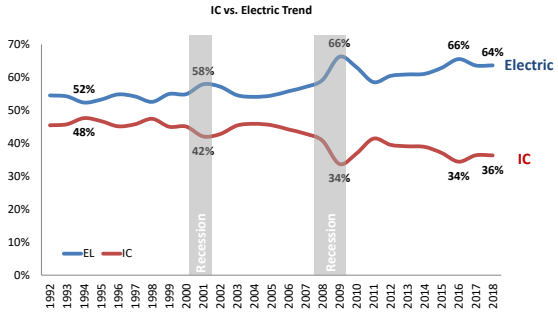
The market for platform equipment has been significantly impacted by recent ANSI regulations impacting mobile elevated work platforms, splitting them into groups and types based on their use, and also requiring a variety of new safety measures involving a variety of different sensor technologies and adjustments.

Electrification Across Architectures

Improvements in vehicle architectures for electric-powered lift trucks – driven by the availability and improvement of lithium-ion battery systems - have powered growth specific market segments.

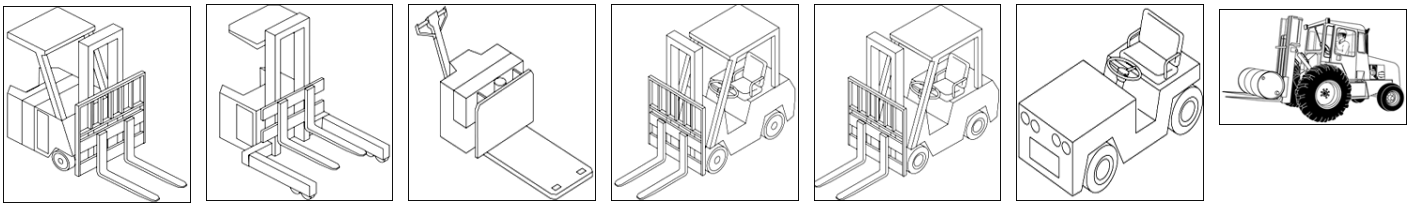
Looking back 30 years, data from the Industrial Truck Association showed the split between electric and internal combustion engines in the North American lift truck industry was 52 percent electric/48 percent IC. Since then, the divide has continued to widen, with latest figures showing 2 out of every 3 lift trucks sold in North America was electric.

Figure 1



MULTIPLE FACTORS IMPACT LIFT TRUCK DECISION-MAKING

From a user perspective, the decision between gas-powered and electric forklifts/lift trucks focuses on their specific use case and working location. These vehicles are separated into 7 different classes.



Class I: Electric motor rider trucks	Class II: Electric motor narrow aisle trucks	Class III: Electric motor hand trucks or hand/rider trucks	Class IV: Internal combustion engine trucks (solid/ cushion tires)	Class V: Internal combustion engine trucks (pneumatic tires)	Class VI: Electric and internal combustion engine tractors	Class VII: Rough terrain forklift trucks

For standard motorized lift trucks (Class 1 and Class 2 for electric and Class 4 and Class 5 for internal combustion) end users have a number of considerations when deciding between electric lift trucks and those with an internal combustion engine. The first core consideration relates to the types of environments and products within the facility.

- **Environmental Conditions** - Historically warehouses with cold storage applications have reiled on gas-powered lift trucks to counteract the negative impact cold has on the runtime of lead-acid batteries. These capacity issues are not as severe with newer lithium-ion models, but the market has not fully embraced that change yet.
- **Product Concerns/Emissions** - Conversely, for customers operating in the food space, electric models are often preferred due to the impact of emissions. Even with ventilation, the use of IC engines in some food environments may not be permitted.

The other main decision driver is the facility's needs in terms of throughput and workload as it relates to charging times for electric lift trucks.

Lead-acid battery models generally require a full eight hours of charging time plus eight hours of cooling time, meaning that each battery could only be used one shift per day before it needed to be swapped out. They also suffer performance degradation as the charge winds down. Lithium-ion battery models can generally extend their battery lives much further, and the fast charging times on newer models also allow for additional options to charge on the fly - during breaks or other down periods - to maintain sufficient battery charge. They also don't need watering or other maintenance required of lead-acid models.

In either case, facilities needed to ensure they have sufficient electric service to the facility to support electric forklifts, and also needed to designate space for battery storage and/or charging stations.

One of the main advantages in using IC-powered lift trucks is that no charging is required. A forklift powered by natural gas/propane can be refueled in minutes by simply swapping out an empty tank for a full one. So in environments when time to charge may not be as readily available, IC-powered lift trucks may make more operational sense.

As the industry shifts toward clean energy, this value proposition is also central to the allure of hydrogen-powered forklifts, which would also allow for a quick tank swap to keep running. Outside of startup costs, the largest challenge in the adoption of hydrogen models has been the larger lack of global infrastructure around hydrogen.

This has the potential to shift significantly in the coming years, with the U.S. Department of Energy using a variety of programs over a 10-year period in a goal of reducing the cost of hydrogen to $1 per 1 kilogram. At the same time, hydrogen fuel cell costs have dropped 60 percent since 2006, and technologic advancements have reduced the cost of electrolyzers needed to produce hydrogen by 80 percent since 2002.

The other factor impacting end users' choice of lift truck is one of cost. While the continued growth and cost reduction

of battery technology has driven down costs for electric models, they still tend to cost about 20 to 25 percent more than comparable IC-powered forklifts.

The other side of the cost of ownership paradigm is ongoing maintenance – an area where electric forklifts far outperform IC-driven models. A study by New Equipment Digest and Toyota Material Handling found that electric models may be as much as 75% cheaper to operate than propane models.

This is driven both by the cost of propane – which has only increased since the pandemic – compared to electricity prices, as well as the fact that electric lift trucks have fewer moving parts to replace and maintain.

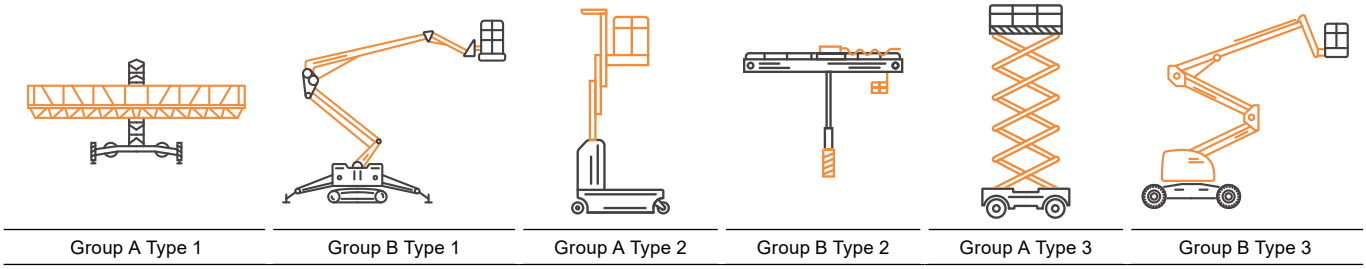
Data shows continued expansion for electric models, with data from the Industrial Truck Association noting that electrics outsold internal combustion models in both 2019 and 2020 – a trend which hadn't occurred once previously since it began tracking the data in 1995.

Overall, the growth of newer electrified models has driven manufacturers to move toward fully electric architectures, impacting their choices of motor controller and other features to allow for greater flexibility.

MEWPS ADDING NEW SENSOR CAPABILITIES, MORE ELECTRIC COMPONENTS

Mobile elevated work platforms (MEWPs) have also undergone significant transformations during the past several years, with much of the change driven by new ANSI regulations.

Under the new guidelines, MEWPs are broken into Groups 1 and 2 and Types 1, 2, and 3 based on how they can extend in relation to the chassis as well as whether the machine can move with an elevated platform.



Those standards also incorporated a number of different safety requirements, requiring load and tilt sensing features which limit functionality if the weight is and/or tilt of the machine is outside safety limits – forcing operators to rectify the issue to prevent accidents.

The trend of electrification has also impacted MEWP designs, but in somewhat different ways compared to lift trucks.

Hybrid architectures have been common with a significant portion of MEWP designs for a number of years – with the equipment running off battery power during the day and then leveraging a gas-powered generator to recharge overnight. Job site limitations around electricity likely mean some internal combustion system is still a requirement for some vehicle classes and types. However, emission reduction regulations in Europe and elsewhere – particularly around smaller, interior-only platform units – are driving many machines toward all-electric structures built on newer lithium-ion power designs.

In many ways, the way electrification has taken hold in MEWP designs has been the shift away from hydraulic components and toward fully electric actuators and other modules. That transformation has the potential to lead to lower equipment maintenance costs over time, and the elimination of hydraulic fluids from the system eliminates the potential for fluid leakage in finished spaces.

The MEWP market is expected to experience significant growth across a number of sectors in the next several years, with Future Market Insights projecting a 12 percent annual growth in aerial work platform sales through 2031, driven partially by an increase in government infrastructure spending. A significant portion of that growth is expected to be in small-format MEWPs, where urbanization has created an increased need for equipment which can work in small spaces and replace ladders and scaffolding to reduce potential worker injuries.

Future Trends Toward

As consumers have seen in the automotive market, the continued evolution of lithium-ion and other battery technologies will continue to make an impact in the design of lift trucks and MEWPs, along with other trends. That shift may lead to greater electrification in vehicle types currently only fulfilled with combustion engines, such as boom lifts and telehandlers.

In any case, seeing how the next phase of megatrends will affect the material handling industry is worth following.