

Lithium-ion Batteries

With electrification becoming an important trend across many industries, the batteries used to power these vehicles are more in the spotlight than ever. Lithium-ion batteries promise to offer higher energy density, better performance and a longer lifespan than previous technologies. We conclude that lithium-ion battery technology is here to stay and its annual demand will only increase. Innovative financing options will be needed to fully utilise this new and ever changing technology.



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Introduction

This document aims to summarise our key findings from a project conducted to investigate lithium-ion battery technology and the impact on the industries of Construction, Transportation and Industrial.

Our approach included input from internal stakeholders, desk research, trade show attendance and 15 interviews with industry experts, battery manufacturers and OEMs. The scope of the project was lithium-ion batteries, alternative technologies and allied technology, focusing on the forklift, bus, truck and construction equipment sectors in Europe and North America.



Alternative technologies

There are many alternative energy sources used worldwide.

The main alternatives to IC engines are:

- Lead-acid batteries
- Liquefied/ compressed natural gas
- Lithium-ion batteries
- Hydrogen fuel cells
- Super/ ultra capacitors
- Solid state batteries

Some of these alternatives, like lead-acid batteries and liquefied/ compressed natural gas, have existed and been used for many years. Others, such as lithium-ion and hydrogen, are gaining popularity in the market today and super/ ultracapacitors and solid state batteries are still very uncommon. There are also several types of lithium-ion battery, with new ones evolving all the time with different applications. It is important to note that whilst technology advances quickly and new alternatives are continuously being developed, it takes a long time (10-15 years) for new technologies to move from an academic level to being used in industry.

Hydrogen has a very high energy density and will become the preferred alternative to li-ion if there is one, with big investments in US, China, Germany and France. It is particularly suited to applications with long driving distances and no standard routes. However,

hydrogen is currently expensive to produce and only 25% efficient (batteries over 90%), with the energy taken to create it more than the output produced.

It is expected that there will not be one energy source of the future and that alternative technologies will co-exist alongside each other, depending on the application.

The Materials Handling industry is the earliest adopter of lithium-ion battery technology among the construction, transportation and industrial industries.

The majority of industry players and experts believe that lithium-ion will be the leading alternative technology to IC engines for materials handling, at least for the next 5 years. Li-ion is well suited to this application due to the availability of opportunity charging, is becoming economically viable for selected applications and several major manufacturers expect large proportions (30-50%) of their trucks to be fitted with li-ion over the next 10 years. The main alternative, lead acid batteries, will remain in place for some time but hydrogen fuel cells are not expected to be a widely used alternative.



In the bus market, diesel buses still take a big share of the market but there are huge government pushes for electric buses. A wide range of alternative technologies are being explored in the industry, without a clear indication of the winner yet. Alternative technologies include hybrids (currently becoming more widely used), liquid/ compressed natural gas, li-ion batteries (in the early stage of development and primarily used for city busses) and hydrogen (OEMs are lobbying due to possibility to switch easily from traditional engines).



In the construction market, selected construction OEMs are exploring lithium-ion to power their electric machines, although the first commercial use of this is not expected until 2019/2020.



The truck industry are beginning to explore lithium-ion, but mostly for short distances and last-mile delivery trucks. Retrofit options are also interesting for this industry, although it is still early stages.

In each sector, some manufacturers are really leading the way with lithium-ion technology, whereas others are following behind and now trying to catch up. Most OEMs are working with battery system suppliers, some of which are general lithium-ion battery manufacturers and some are focussed on a specific industry but manufacture a variety of battery types. **Both the OEMs and battery manufacturers want certainty about the batteries and are looking for financing solutions.**



Lithium battery market

Based on our research, there is no doubt that li-ion power is here to stay.

Its annual demand will increase threefold for EVs and nine fold for energy storage by 2022. Similarly, the lithium-ion battery market for industrial use is expected to grow at a CAGR of 20% between 2014 and 2025¹.

The advantages of lithium-ion for the user include:

- Higher energy density and performance
- Easy and fast opportunity charging
- Maintenance-free
- Safety
- Warehouse space saving
- Longer life and more lifecycles
- Less emissions
- Less noise pollution
- Lower TCO
- Improving economic viability in the countries with high fossil fuel costs

However, the high price of lithium-ion batteries has been a barrier to adopting the technology. The price of li-ion is still significantly above lead-acid, but has been decreasing steadily over the last several years,

and in the last couple years it became economically viable for selected applications. Economies of scale (fueled by Gigafactories for EVs) will have the biggest effect on pricing and will drive battery costs to decline, although at a slower rate than previously. Whilst the cost price of li-ion batteries may come down, the demand will increase which will push up selling price and could stabilise the selling prices. The low cost of fossil fuels in the US also means that lithium-ion batteries are relatively priced even higher than in Europe.

A lithium-ion battery is considered to be at the end of its first life is when the battery reaches 60-80 % capacity, normally in **3-8 years** for most industrial applications. However, this is affected by the charging pattern and it is optimal to only charge between 30-80%. The usual warranty provided for lithium-ion batteries by the manufacturers is 3-8 years or 3-5 years for forklifts (or specific hours). Reuse of the battery in less intensive applications, such as stationary energy storage, is the best option for second life, for up to 5 years. Second-hand market information is limited due to the limited number of batteries that have reached the end of their first life. Recycling and refurbishing are not currently viable but this expected over the next couple of years.

1. Grand View Research, Lithium-Ion Battery Market Analysis and Segment Forecasts To 2025



Financing

It is important that financing solutions follow the trends, keep up with the ever changing technology and continue to adapt to suit the needs of our customers.

With the higher price of lithium-ion and the uncertainty of future pricing, it is important that asset management capabilities are developed and enhanced to set competitive residual values for this new technology.

The rental market for batteries with manufacturers is expanding, with the option to rent the battery separately to the equipment, overcoming the potential problems of the batteries having a different lifespan to the equipment.

With higher equipment costs, financing options are an ideal way to be able to make use of lithium-ion technology, and reduce the total cost of operation, without a higher initial outlay. **DLL is currently developing pay-per-use solutions that will enable users to get the full benefit of using batteries without having to own them.**

Thank you to all the experts and interviewees who helped us to conduct this research and we are more than happy to stay in touch with upcoming developments. Further details and information are available on request.

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