



## A review paper on challenges and opportunities in battery technologies

Anojkumar Yadav<sup>1</sup>, Mukesh kumar Mishra<sup>2</sup>

<sup>1</sup>(VIVA Institute of Technology, India)

<sup>2</sup>(VIVA Institute of Technology, India)

**Abstract :** As the battery demand increases due to the fast-growing economies, energy security, increasing use of the renewable system, electric vehicles, smart cities, etc. there will be a need to evolve new battery technologies. Battery technologies have emerged significantly still, there are some challenges in the present technology. This paper reviews different challenges and opportunities that arise in the use of battery technologies. This paper also focuses on the concept of battery swapping as electric vehicles survive on batteries. The research work on the new battery which is developed also discussed in this paper.

**Keywords -** lithium-ion batteries, battery demand, battery swapping, battery recycling

### I. INTRODUCTION

As the energy demand increases day by day there is a need to increase energy production. Not only energy production but clean energy production keeping in mind environmental concerns. According to statistics of the Indian electrical power sector, 75% of energy demand is fulfilled by fossil fuels which release approximately 2,000 metric tons of carbon dioxide into the environment. To reduce GHG emissions there is a need to generate electricity by using renewable energy sources and to convert diesel-petrol vehicles to electric vehicles. To achieve this, the battery plays a very important role to store energy.

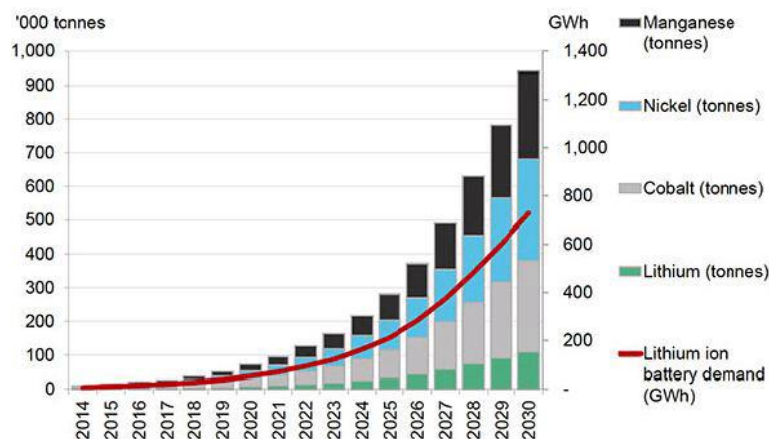


Fig 1. Demand of material for battery manufacturing

It is observed from the graph that demands energy storage devices, especially battery technologies rising exponentially. There are so many battery technologies but lithium-ion battery technologies are in more demand as it dominates the other battery technologies. Lithium-ion batteries have a much higher energy density and high life cycle. There are the following types of lithium-ion batteries:

- Lithium manganese oxide
- Lithium iron phosphate
- Lithium nickel manganese cobalt oxide
- Lithium nickel cobalt aluminum oxide

- Lithium titanium oxide

## II. BATTERY DEMAND

Generally, batteries are used to store the energy when it is available and use that stored energy in different time slabs when it is needed. Battery demand is increasing because of the power sector and the automobile sector. In the power sector, renewable energy technology (Solar power plants) generates energy in the daytime and surplus energy is stored in batteries which are utilized at night time. As the use of renewable energy sources increases to increase energy production and lower GHG emissions, there is an increment in the demand for battery technologies. The second Sector where the requirement of batteries is the automobile sector as the use of electric vehicles increases the requirement for battery technology also increases.

## III. ROADBLOCK IN BATTERY TECHNOLOGIES

There are certain roadblocks in the progress of battery technologies are as follows:

- I. Thermal Management of batteries is the main issue. Batteries are suitable to work in temperatures around 40 degrees Celsius but in India, temperature increases up to 48 to 50 degrees Celsius. Due to high temperature, the liquid electrolyte used in the battery gets to expand and putting stress on the outer casing results in bulging, cracking, or even puncture of the battery casing.
- II. Due to the charging and discharging of the battery continuous electrochemical processes happen. Results in after a few hundred charge-discharge cycles internal resistance of battery increases and the battery cannot be used in the electric vehicle if degraded up to 70% SoH.
- III. The raw material reserves are an important parameter in the development of the battery manufacturing system. India does not have reserves of lithium and also there is a heavy dependency on Cobalt and Nickel import.

## IV. CONCEPT OF BATTERY SWAPPING

Batteries are an integral part of electric vehicles and cannot be separated from each other. The fixed battery system in which the battery is embedded in the chassis of the electric vehicle is non-removable. Whereas a swappable battery is easy to remove from the vehicle and replaced with a charged battery. So so definitely some differences in vehicle design for fixed battery systems and swappable battery systems. In a fixed battery system, the chassis is designed with the consideration of a fixed battery. In a swappable battery system, the batteries have to be easily removable and they must withstand mechanical vibrations. As in a swappable battery system, the batteries are removed and inserted frequently, so connectors have to be designed according to the requirement.

Table 1: Battery System and Features

Type of battery system	Features
Fixed battery system	Suitable to short distance vehicle Personal Vehicle No standard battery model required May hamper due to long charging duration
Swappable battery system	Suitable to long distance vehicle Commercial vehicle Standard battery model required Hamper due to heavy investment

## V. BATTERY RECYCLING

Battery consists of various toxic heavy metal which when discarded carefully otherwise it can pollute the air and soil. With increase in the use of battery, a significant problem of battery waste management and recycling arises which can cause serious environmental issues. From spent batteries valuable metals and other materials can be recovered. It can be processed and then reused. Today market of battery recycling is low but in future it is expected to grow 24% more as battery uses goes on increasing.

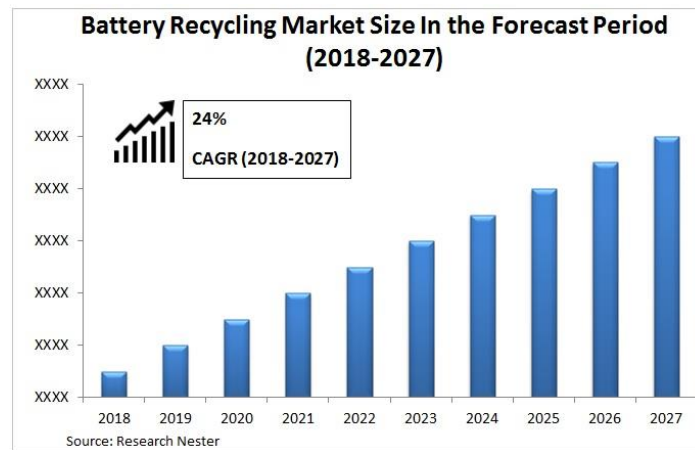


Fig 2. Battery Recycling Market

## VI. CONCLUSION

This paper concludes that with the growth of power sector and automobile sector uses of battery also increases. So there is need to develop the battery energy storage technologies. Research work is needed in some area which creates roadblocks in the development of battery technology. Due to several advantages lithium-ion battery dominates the market but alternative of Lithium ion needs to be invented. Along with that its management of spent battery is also important to prevent environmental hazard.

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