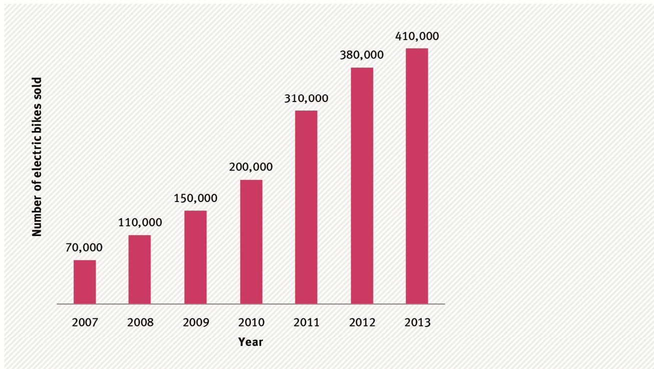
Recycleability of E-bikes

Not only a question for retailers but also for customers
Returning and recycling Pedelecs and rechargeable batteries

Introduction

Pedelecs and E-bikes derive their energy from rechargeable batteries of numerous varieties and designs i.e. most pedelecs in Germany are equipped with lithium-ion-batteries (Li-ion) and in rare cases with nickel-metal hydride (NiMH) batteries. Due to various ageing processes that depend upon time, environment conditions and user behaviour, the available capacity decreases with a pedelecs use. The number of pedelecs sold annually grows (see figure "Number of electric bikes sold in Germany annually") in Germany; in future, a time-delayed heavy increase in the quantity of discared rechargeable batteries will ensue.

Number of electric bikes sold in Germany annually



Source: ZIV, own depiction[17]

Environmental relevance

Thus, due to the high environmental relevance of battery manufacturing and with that coming the use of rare earth metals, a battery‘s lifespan is the decisive parameter when it comes to the climate and environmental impacts of a pedelec. According to a prognosis in 2020 the potential amount of neodymium in Germany can expect to recover from old pedelecs: 5,6t which is more than the projected amount of neodymium that can potentially be recovered from old wind turbines (2,9t). Therfore consumers should take account of the guaranteed durability of the battery.

Recycling

Due to the increasing number of Li-ion batteries recycling processes are developed worldwide for these systems. Economically interesting materials are in particular cobalt, nickel and copper but the recycling of lithium is also aimed because of predicted potential supply shortages. In the BMBF (Federal Ministry of Education and Research, Germany) projects LiBRi and LithoRec an LCA for battery recycling was also carried out parallel to the development of recycling processes. The results of these analysis showed that a high recycling efficiency (in some cases even up to 99 %) can be reached for the compounds of lithium, cobalt, nickel, manganese, aluminum and copper.

Typical characteristics of rechargeable battery types used in Pedelecs

Battery type	Energy density in Wh/kg	Components/ ingredients	Lifespan/maximum no. of charge cycles depending on use	Advantages and disadvantages
Lithium-ion ($LiMn_2O_4$)	110 - 130	lithium manganese copper aluminium graphite	Up to 1,000 charge cycles	+ low self-discharge + high level of stability and safety + low costs
Lithium-ion ($LiFePO_4$)	110 - 130	lithium iron phosphate copper aluminium graphite	over 1,000 charge cycles possible	+ low self-discharge + very high level of stability and safety + can be charged quickly + long lifespan + good raw material availability
Lithium-ion ($Li(NixCoyMnz)O_2$)	140 - 160	lithium cobalt nickel manganese copper aluminium graphite	over 1,000 charge cycles possible	+ low self-discharge + high energy density + long lifespan
Lithiumionen ($LiCoO_2$)	140 - 160	lithium cobalt nickel copper aluminium graphite	up to 1,000 charge cycles possible	+ low self-discharge + high energy density - high costs
Nickel-metal hydride (NiMH)	55 - 100	nickel iron cobalt rare earths (lanthanum, cerium, neodymium, praseodymium)	up to 1,000 charge cycles possible	+ very high level of stability and safety + low costs - Very high self-discharge rate (approx. 20% per month) - low energy density

Source: summary depiction[80]

Extending durability

Experiences of recent years have shown that Li-ion batteries installed in e-bikes reach the end of their life in about 3-5 years. Simple steps can extend the lifespan of a battery:

- Over-discharge and overcharge should be avoided. Do not wait until the battery is fully discharged – lithium ion batteries have no memory effect (loss of maximum energy capacity when repeatedly recharged) – an additional charging cycle with a complete discharge is not necessary.
- Be careful where you park your e-bike. Avoid, if possible, overheated "woodsheds" or bicycle stands in the blazing sunlight. Temperatures above 30 °C often lead to an accelerated aging of the battery.
- During longer storage the battery should not be stored above room temperature and preferably have a charge level of around 50%. Within six months, the battery should be recharged.

Future aspects

Technical processes to reuse and recycle permanent magnets containing rare earths from waste streams are currently in development; these efforts are primarily motivated by the growth of electro mobility.

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