Lithium batteries limiting the energy transition

But there is good news, too….

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It becomes more and more obvious how energy storage systems will contribute to the energy transition in the future. Not only the storage capacity or the size matter but even more important the safety aspect of the energy storage system will become a key decision aspect. We have seen quite a few examples where energy storage systems based on a lithium chemistry cause a lot of problems. One of the most remarkable is the big fire at the Carnegie Road 20MW energy storage system near Liverpool (UK). Lithium batteries were involved during this serious incident.

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The use of lithium batteries and the involved risks make other countries also look with more criticism to its application. Think about the even more rigid directives for road transport. Lithium batteries are considered dangerous goods according ADR guidelines (The European agreement on road transport of dangerous goods). The American government provides similar guidelines (https://www.phmsa.dot.gov/) according the US department of Transportation.

When we dive a little deeper into this matter, we first of all find a formal notification from the Dutch government. (formal notifications are no laws but an informational document that may be come implemented partially or fully in a future law, local legislation or directive for local councils). For Dutch readers see: https://wetten.overheid.nl/BWBR0043769/2020-07-01

This formal notification describes the conditions that apply for the use of lithium-ion batteries in a wide range of applications. The government is very clear on the use of lithium batteries for example households, vehicles but also energy storage systems (in short ESS). The introduction of this notice makes it all clear in a glance: "*Due to overheating a so-called thermal runaway can originate from the battery and cause intense fires and the emission of toxic gases/substances. During incidents with this type of storage medium danger to the direct environment can not be ruled out."*

First of all a short introduction to the phenomenon of "Thermal runaway": This concerns an irreversible proces of a strong increase of the temperature in one of the battery's cells. (what we call a battery is basically build up from a group of cells). This heat can originate from an external heat source like a short circuit or fire but also from an overload or short circuit in the battery itself. More specifically the forming of dendrites in the lithium battery contributes to the chances of a thermal runaway. Among other scientifical research instutions The Royal Society of Chemistry published an article about dendrite forming and the consequences some time ago: https://pubs.rsc.org/en/content/articlelanding/2020/se/d0se00027b#!divAbstract

What are dendrites in batteries?

Dendrites may remember you of your biology lessens in high school. They take care of transmitting electrical pulses between nerve cells. However, in lithium battery cells a similar process takes place. By using an MRI scanner it appeared to be possible to see the origination of dendrites. In fact a dendrite is a kind of shoot that forms between the cathode and anode of a battery cell. These dendrites are electrically conductive and when the cathode and anode are connected by a dendrite a short circuit follows. The short circuit current that flows between the cathode and anode results in a rapid thermal heat process causing a thermal runaway that quickly propagates to other cells and adjacent batteries.

The thermal runaway process is hard to stop. Some say it is even impossible and that's why it is called irreversible. On Youtube there are a lot of examples about how the thermal runaway process progresses. You can find even some explosive examples where the stored energy comes free at once in the form of intense heat, explosion and toxic gases.

Ok, that said let's go back to the formal notification from the Dutch government. In paragraph 5.2 – Demarcation ESS the authors dive deeper into the application of lithium batteries in energy storage systems. Energy storage systems with a storage capacity of >100kWh should comply with the directives as stated. This explicitly does not mean that smaller systems should not. In fact, manufacturers of systems with a storage capacity of >25kWh should seriously consider these guidelines as well. Some of the guidelines for lithium batteries used in an ESS:

- Keep the SoC (State of Charge) between 20 and 40% of the total capacity during transport
- Reconsider the location because of the fire risk and forming of toxic gases concerning the environment
- Protect and monitor access roads to the energy storage system
- Etc. etc.

But… now a problem emerges concerning safety and the ever speeding up process of the energy transition. Does the most commonly used (lithium) energy storage medium limit the progress of the energy transition?

The answer is two-folded:

Yes, because the now most commonly used storage media in the form of a lithium battery seems to have safety issues. No one will accept a container with potentially exploding or self-igniting lithium batteries. Not to even consider an energy storage unit mounted against your garage wall! On the other hand the use of energy storage systems are an inevitable requirement to sustain the use of renewable energy sources like solar, wind or tidal. The fluctuations in the energy supply because of these non-stable (weather dependant) sources require buffering and controlled supply of the energy.

No, because the market offers us also excellent alternatives for lithium batteries. An often used type is the so-called flow-battery. This type of battery works with liquids barrels and a pump. See how Wikipedia explains this:

“A **flow battery**, or **redox flow battery** (after reduction–oxidation), is a type of electrochemical cell where chemical energy is provided by two chemical components dissolved in liquids that are pumped through the system on separate sides of a membrane.[2][3] Ion exchange (accompanied by flow of electric current) occurs through the membrane while both liquids circulate in their own respective space. Cell voltage is chemically determined by the Nernst equation and ranges, in practical applications, from 1.0 to 2.43 volts.”

But, the disadvantage of this type of battery is the low energy density which requires a certain amount of space. In this article I will not discuss all different types of batteries but only the one type that is most suitable as an alternative for the lithium battery. This concerns the nickel-metal hydrid battery (NiMH). This type of battery is compact, consists of a waterbased electrolyte, does not have any chance on thermal runaway and is very suitable as storage medium in a battery energy storage system.

Hence, the application of this type of battery offers the energy transition process to progress even faster without being limited by the technical properties of lithium batteries. To comply with the increasing demand for NiMH batteries the manufacturers are expanding their production capacity in Europe at this very moment. The most commonly used battery in battery energy storage systems will change in chemistry from lithium to the nickel-metal hydrid battery in the future. At least that is our expectation.

Some more good news: The Dutch manufacturer of energy storage systems: Mc Energy® BV in Ridderkerk, The Netherlands, already uses this type of battery in their ESSs and therefore receives worldwide attention for it.

Summarizing we can say that the energy transition will only florish when safe and reliable energy storage systems are used. The Dutch government already took the first step by writing this formal notification as a preparation for future legislation and the market can and will take the next steps to contribute in achieving this goal.

Want to know more? Contact the author through alex@mc-nrg.com