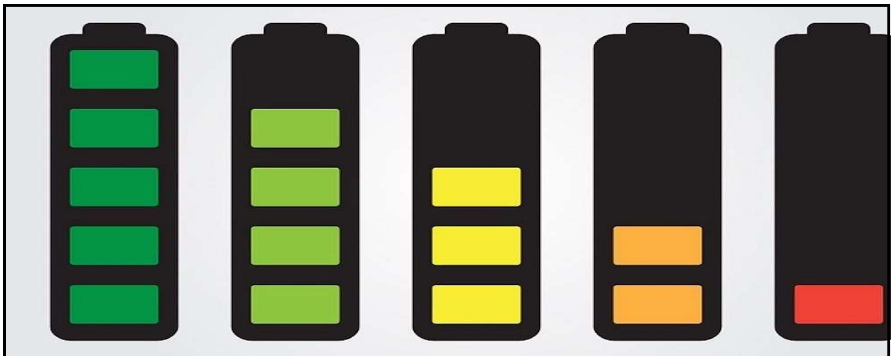

FOLLOW-UP FEASIBILITY STUDY ON SUSTAINABLE BATTERIES – TASK 2 CHARACTERISATION OF REQUIREMENTS FOR E-MOBILITY AND STATIONARY APPLICATIONS

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TASK 2 CHARACTERISATION OF REQUIREMENTS FOR E-MOBILITY AND STATIONARY APPLICATIONS

Objective of Top-up study

- Verification applicability of performance and sustainability requirements for battery technologies and chemistries other than lithium ion, and what adjustments might be necessary.

- Key challenges
  - The proposed requirements on sustainability can be easily applied to other chemistries.
  - The extension of the performance requirements on battery life time is a challenge:
    - standards are incomplete or missing
    - no reliable set of public available data to set thresholds.

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TASK 2 CHARACTERISATION OF REQUIREMENTS FOR E-MOBILITY AND STATIONARY APPLICATIONS

New scope definition

- Rechargeable batteries of high capacity with internal storage for e-mobility and stationary energy storage (if any)'. High capacity means that a total battery system capacity between 2 and 1000 kWh.
  - Note: battery system ≠ battery application system

Chemistries for applications

- Electric vehicles:
  - Lithium chemistries
    - Li-ion, lithium alloys, lithium metal and lithium sulphur
- Stationary:
  - Many chemistries possible

TASK 2.4 SCREENING FOR STATIONARY APPLICATIONS

Minimum battery pack/system lifetime requirements

Conclusion on policy measures for ESS

- The current policy propositions appear only feasible with Li-ion batteries.
  - mainly due to a lower efficiency for all other battery chemistries (as far as information was found).
- The best batteries after Li-ion regarding efficiency are NiMH and lead-acid
  - under the condition that they are not fully charged often since there most energy loss occurs.
    - For NiMH it is not problematic to avoid full charges, even in the contrary.
    - For lead-acid this is only possible for batteries that are dedicated for so-called "partial SOC" (pSOC) operation.
- A lifetime of 20 years is for several chemistries possible: Li-ion, NiMH, NiFe and NaS.
  - If this criterion is decreased to 15 years also $NaNiCl_2$ and hybrid-ion are possible.

Minimum battery pack/system lifetime requirements

Conclusion on standards analysis

- Needs from standards:
  - a representative cycle life test
  - measurement methods of needed performance indicators
    - (remaining) energy contents
    - Efficiency
- Only for $NaNiCl_2$ and NaS all needed information is covered
- Standards are lacking for NiFe, hybrid-ion, LiS and Na-ion
- Other battery types
  - the standards do not cover the performance indicators
  - the cycle life tests are not representative enough or too time consuming.

Requirements for battery management systems

Conclusion on policy measure

- Half of the chemistries use a BMS
  - Li-ion, Li-metal, sometimes NiMH, $NaNiCl_2$, NaS and Na-ion.
  - Probably of the advanced type, that is capable to perform analytics on the remaining capacity
- Necessity of partial open data on the remaining battery quality
  - Currently only the Li-ion battery type is used for repurposing
  - Follow up of battery degradation also important for a long first life operation
- Recommendation that all long-lasting battery types have ageing diagnostics
  - Implementation possible by an external analysing and logging device.

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Requirements for providing information about batteries

Conclusion on policy measure

- Since not for all battery types an PEFCR exists, the carbon footprint cannot be given for all types.
- Marking symbols exist only for Lithium, Li-ion, lead-acid and NiMH in IEC standards.
- Information requirement on the recycling method
  - Not for all battery types specific information on the recycling method seems to exist.
- Information requirement on the percentage of recycled materials in the battery
  - Recycling up to battery grade must exist in the first place.

TASK 2.5 CONCLUSION ON TECHNOLOGY NEUTRAL POLICY

Concessions on remaining capacity versus life time in policy requirements (1)

- Granting a concession if
  - a battery type requires fewer primary energy to manufacturer and have therefore a similar capacity Energy Efficiency Index (cEEI) as the typical LiB they compete with.
    - capacity Energy Efficiency Index (cEEI) refers to the ratio of declared storage capacity relative to the embodied primary or gross energy requirement (GER) for manufacturing.
  - a minimum functional life time on capacity fade is fulfilled
    - At least 1000 test cycles and 6 years of warranty.
    - correction factor (K_{cycle})

TASK 2.5 CONCLUSION ON TECHNOLOGY NEUTRAL POLICY

Concessions on remaining capacity versus life time in policy requirements (2)

- 2000 cycles at full life can be satisfied by all chemistries, except LiS up to our knowledge.
- The minimum warranty period of 6 years is for most chemistries possible.
- For lithium metal and lithium sulphur data lacks currently.
- For most lead-acid batteries this period is challenging, but there are solar type lead-acid batteries for which it is feasible.

Concessions on remaining round trip efficiency versus life time in policy requirements (1)

- The thresholds cannot be met for other chemistries used in ESS
- A concession can be found in the lower carbon footprint of the battery system
- It is proposed to apply the following correction factor (K_{eff})
- An efficiency below 80% mid-life is deemed unacceptable
  - therefore the corrections can be capped.
- Therefore it is proposed to apply the following correction factor (Keff) on the 2000 proposed cycles
-

TASK 2.5 CONCLUSION ON TECHNOLOGY NEUTRAL POLICY

Concessions on remaining round trip efficiency versus life time in policy requirements (2)

- For Na-ion an efficiency of 85% is needed at mid-life
- For new batteries, which have always better efficiency than at mid-life, 85% seems not reachable for:
  - NiFe and NaS.
  - For LMP, $NaNiCl_2$, and LiS characteristic efficiencies are unknown.
- If the excluded batteries are manufactured with help of renewable energy, GWP_{CAP} decreases, resulting in a lower efficiency threshold, creating a possibility.

TASK 2.6 2.6. ITEMS FOR DISCUSSION

We are especially looking for the following information and stakeholders are invited to contribute

- All performance parameters are lacking for Li-metal batteries.
- Roundtrip efficiency information, especially for ESS application (characteristic efficiency), is lacking for:
  - Li-metal;
  - NiMH;
  - NiFe;
  - $NaNiCl_2$.
- Remaining capacity at EOL is lacking for:
  - NiFe,
  - $NaNiCl_2$.
- Stakeholders are welcome to provide examples and alternative proposals for granting concessions on the proposed policy.