Review of battery second life concepts and projects

Peter Stenzel (p.stenzel@fz-juelich.de), Wilfried Hennings, Jochen Linssen
Institute of Energy and Climate Research – Systems Analysis and Technology Evaluation (IEK-STE)

JÜLICH FORSCHUNGSZENTRUM

Research topic

The trend to electrify the transport sector and the resulting worldwide increasing demand for electric vehicles lead to a growing demand for traction batteries. In the following decade an increasing amount of batteries might be available for possible second life applications after the batteries have reached the end of their first life. Second life concepts offer the opportunity to extend the battery usage period, however, the technical and economic feasibility of these concepts remains unclear so far. This contribution aims to classify different approaches and analyzes related trends in research and demonstration. Based on a literature review, past and ongoing research activities and demonstration projects are evaluated.

Second life classification and trend analysis from project evaluation

Second life concepts can be generally defined as the utilization of a battery which after usage in a first life application is removed from this application and further used in a second life application. Typically, but not necessarily, the applications differ in the first and second life. Most common example is the use of traction batteries in stationary applications. Based on a worldwide project evaluation, in total 30 second life activities, including demonstration, commercial projects and companies which offer second life solutions, have been identified. Fig. 1 presents a general classification of second life concepts.

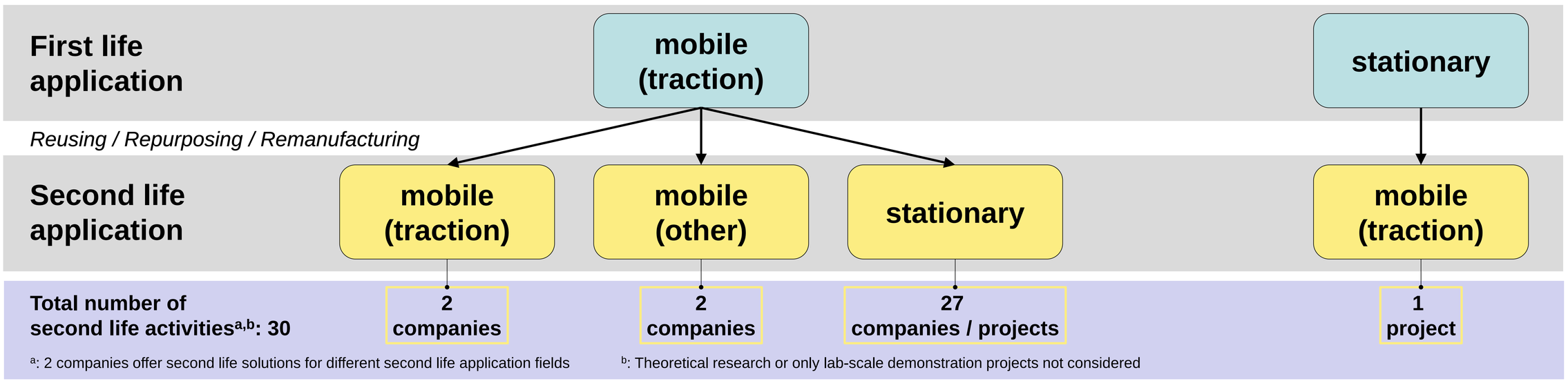


Fig. 1: General classification of second life concepts distinguished after first life and second life applications and related number of second life activities

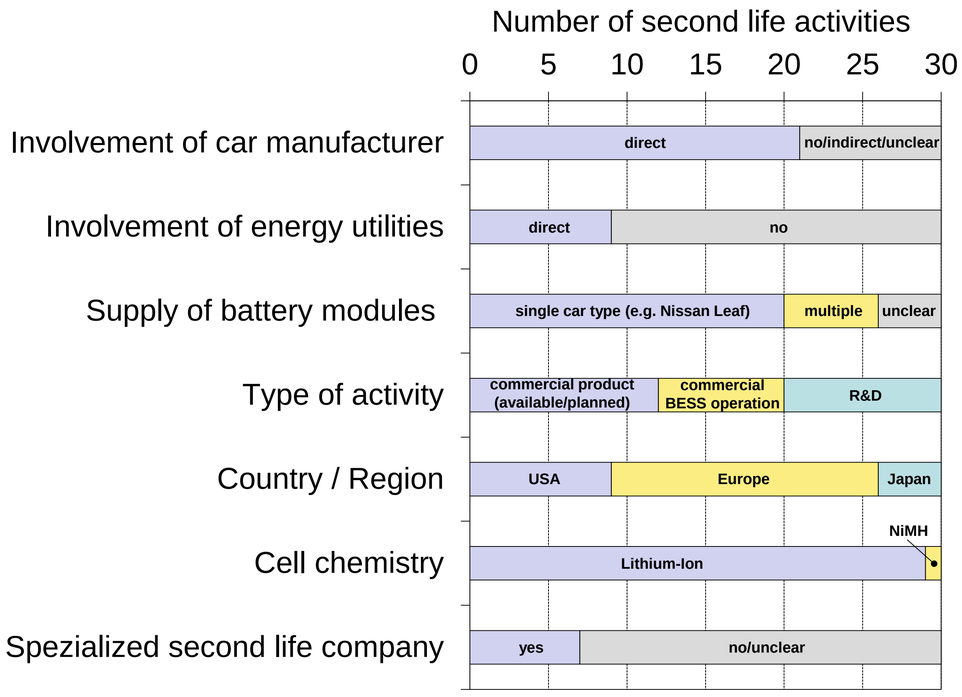


Fig. 2: Evaluation of second life activities

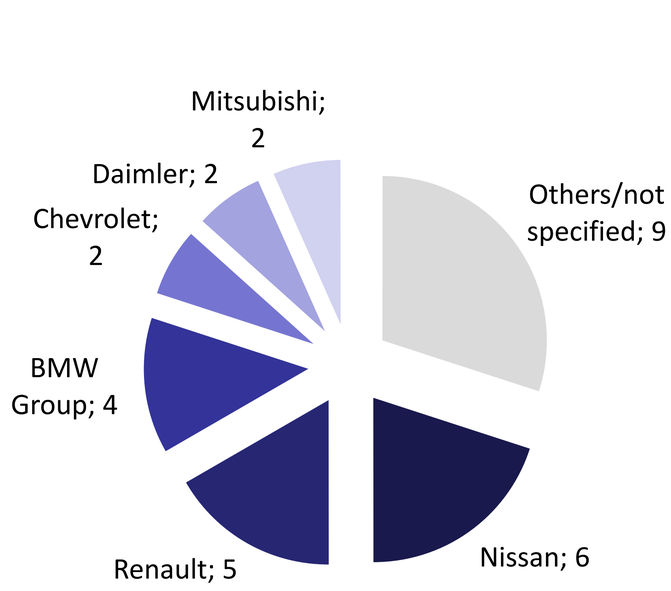
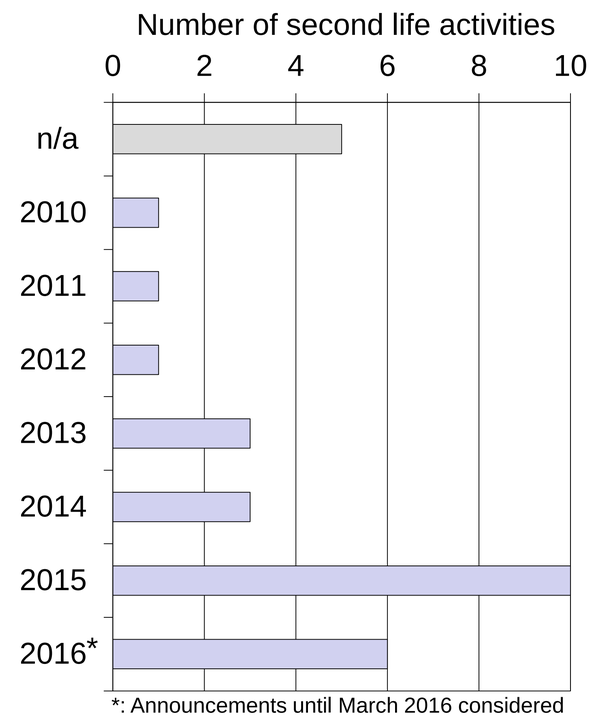
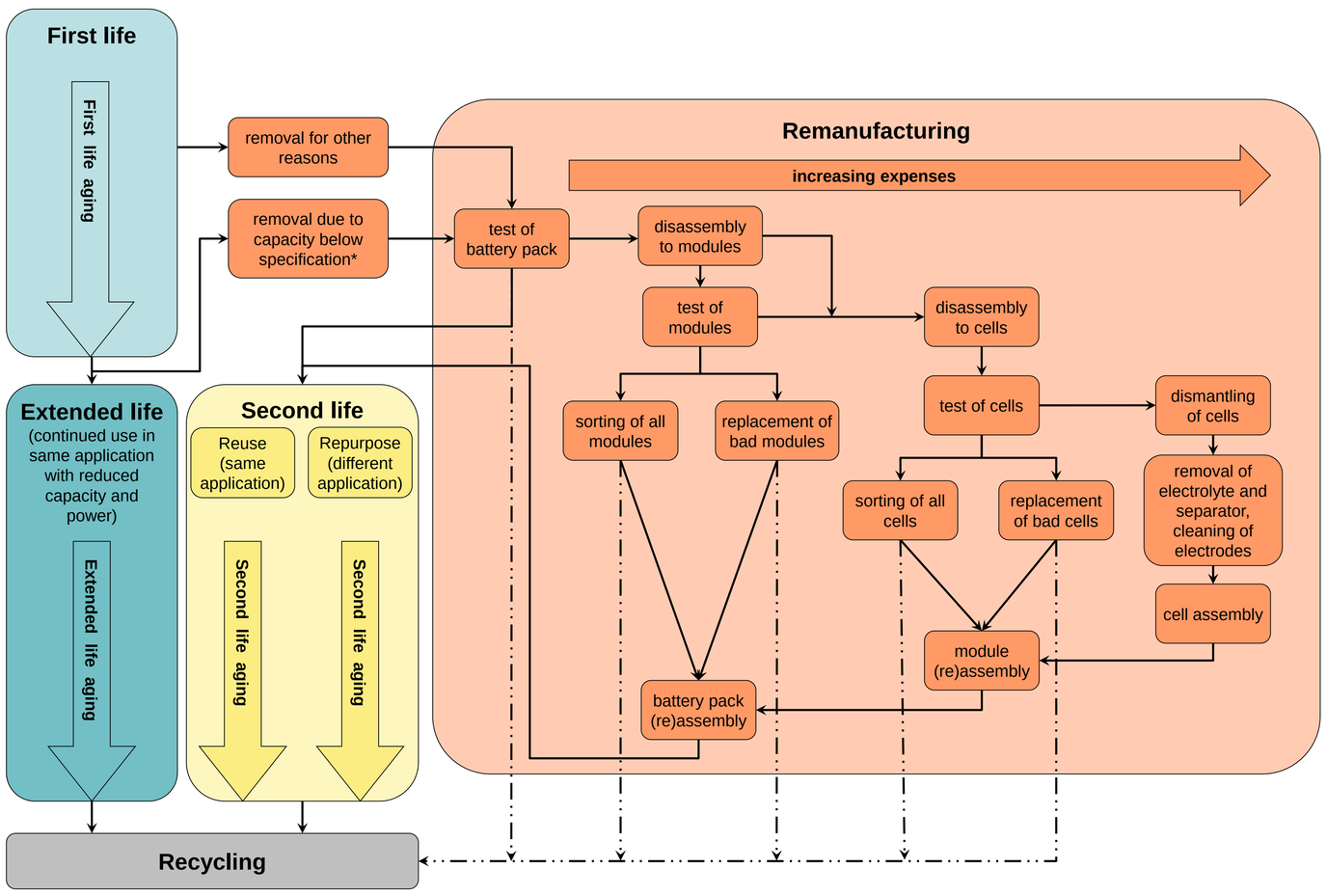


Fig. 3: Number of second life activities by car manufacturer



*: Announcements until March 2016 considered

Fig. 4: Development of second life activities by year of start



* e.g. guaranteed traction battery capacity: ≥ 70 % or ≥ 75 % of initial capacity
* average warranty limit for the battery by the car manufacturer: 8 years, 100 000 km (EU) / 100 000 miles (USA)

Fig. 5: Schematic of second life and remanufacturing concepts

Conclusion

- The development of second life concepts is still at the early stage.
- Large uncertainties exist regarding costs for second life concepts and battery lifetime in second life applications.
- Price development of new batteries has to be considered regarding the economic viability of second life concepts.
- Useable second life capacity and lifetime but also costs increase with increasing degree of remanufacturing.
- Second life optimized battery modules and BMS designs are one key to enable widespread second life applications.
- Development of battery aging quick tests is a prerequisite for an open market access, independent from car manufacturers.