

Grid Integration of Electrical Power Train Systems in Existing and Future Energy Supply Structures

– Development of a Battery Model Considering Aging and Costs –

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<h3>Idea</h3> <p>Power grid connected electric vehicles may reduce capacity requirements of fossil power plant stock by improved utilization of fluctuating renewable energies:</p> <ul style="list-style-type: none"> ▪ Discussion of feasibility and constraints ▪ Analysis of impacts on CO₂ emissions and primary energy consumption ▪ Formulation of cost and operator models 	<h3>Work Program</h3> <p>Development of an energy storage model under consideration of integration into power grids as well as battery aging and cost effects:</p> <ul style="list-style-type: none"> ▪ Consider future development of battery parameters and costs in battery model ▪ Driving cycle and grid service simulation ▪ Requirement specification of electric energy storage 	<h3>Partner</h3>												
<h3>Battery Development</h3> <p>→ Consideration of future battery development in battery model</p>	<h3>Battery Costs</h3> <p>→ Battery costs are essential for market launch of electrified vehicles</p>	<h3>Battery Model Approach</h3> <p>Model for current and future batteries:</p> <table border="1"> <tr> <td>Data</td> <td>Battery aging test series</td> <td>Literature and expertise</td> </tr> <tr> <td>Parameterization</td> <td>ESB-Model parameters</td> <td>Identification of Storage aging</td> </tr> <tr> <td>Modeling and simulation</td> <td>Operation</td> <td>Lifetime model</td> </tr> <tr> <td></td> <td></td> <td>Aging and costs</td> </tr> </table> <p>→ Literature based approach allows parameterization with future values</p>	Data	Battery aging test series	Literature and expertise	Parameterization	ESB-Model parameters	Identification of Storage aging	Modeling and simulation	Operation	Lifetime model			Aging and costs
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<h3>Modeling and Simulation</h3>														
<p>ESB based battery model including thermal, SOC and OCV model:</p> <p>Battery parameters identified with measuring data</p>	<p>Identification of subcycles by detection of local maxima and minima in SOC = f(t):</p> <p>Cycle life depends on amplitude of cycles</p>	<p>Generation one (2010) literature based aging model:</p> <p>Aging is parameterized by literature data</p> <p>Assumptions</p> <ul style="list-style-type: none"> - $A_{cal} = f(T, SOC)$ - $A_{cyc} = f(\Delta SOC)$ - $A_{tot} = A_{cal} + A_{cyc}$ 												
<p>Simulation of real driving cycle:</p> <p>P_{ei} identified with measuring data</p> <p>$P_{charge} = 3.68 \text{ kW}$ $E_{Bat} = 35 \text{ kWh}$ $P_{Bat} = 150 \text{ kW}$</p>	<p>Variation of charging time:</p> <p>→ lower SOC and less frequently charging extends lifetime</p>	<p>Conclusions:</p> <ul style="list-style-type: none"> ▪ Simulation results are valid for a special chemistry with the given assumptions ▪ Here influence of calendar aging is stronger than influence of cycle aging ▪ Additional cycling for example by grid services may be possible 												

Results and Future Work

- ✓ Implementation of a literature based aging model offering consideration of future battery parameters
- ✓ Development and implementation of an algorithm for identification of subcycles by detection of local maxima and minima in SOC = f(t)
- ✓ Literature research about present and future battery characteristics and costs
- Development of next generation battery model
- A model for present and future battery costs will be integrated in the battery model
- On the basis of grid service and driving cycle simulations technical as well as monetary possibilities and limitations will be formulated

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