

RANGE ESTIMATION FOR ELECTRIC VEHICLES

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ABSTRACT

Economic electrical vehicles suited for daily use will have limited traction battery capacity. Thus reliable range estimation is a mandatory feature for route planning. Energy consumption and CO₂-emission based on the actual standard test cycles (NEFZ, CADC) is much too optimistic, especially for rural operation in mountainous regions. In this contribution we present a Simulink-based electric vehicle model that considers all relevant route characteristics (altitude, speed limit, pavement and weather conditions). The model is applied and validated by different electric compact cars and roadsters with real mountainous test cycles. Based on intensive parameter studies with this model, a simplified analytical model for range estimation, CO₂-emissions and costs (including an optional fuel based range extender) is derived. A case study shows the possible benefit of a low-power range extender for compact electric vehicles.

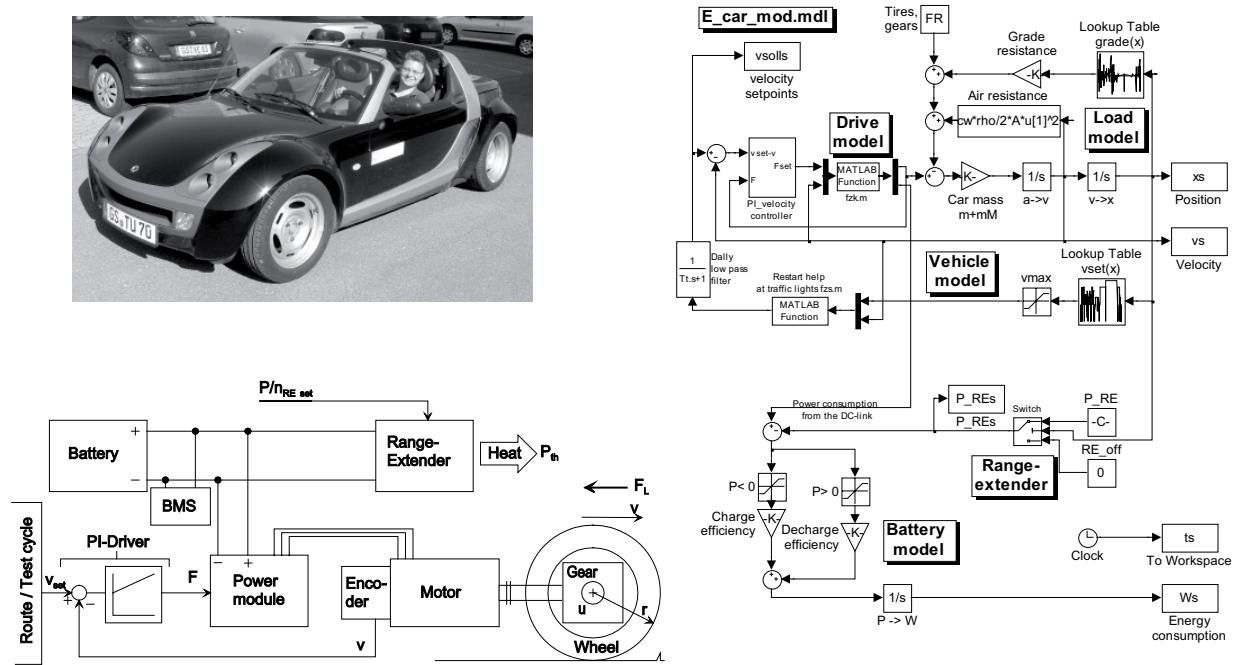


Figure 1: Test car, physical model and implementation in MATLAB/Simulink

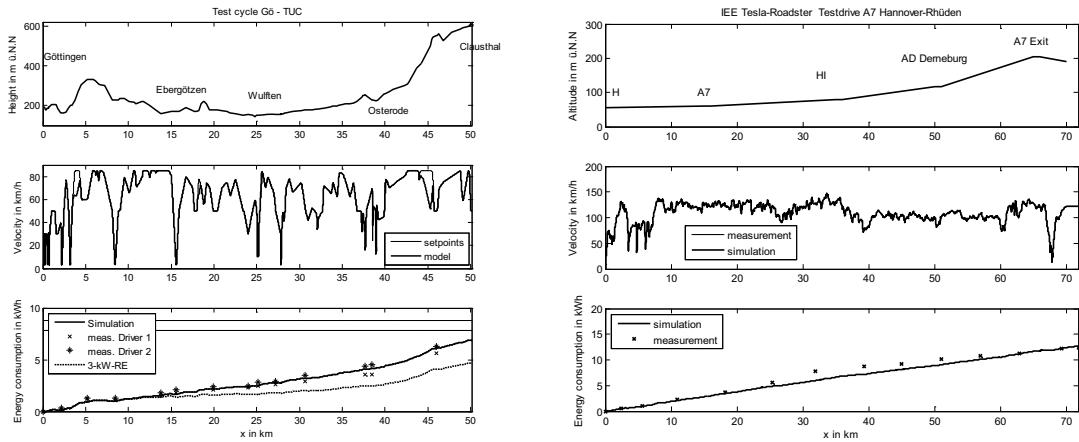
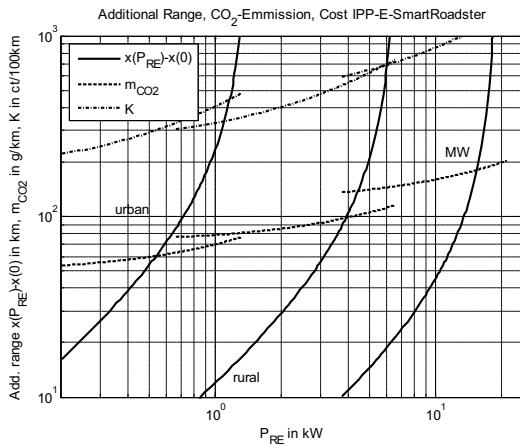


Figure 2: Rural (IPP-E-Smart-Roadster) and motorway (IEE-Tesla Roadster) test cycles

a)



b)

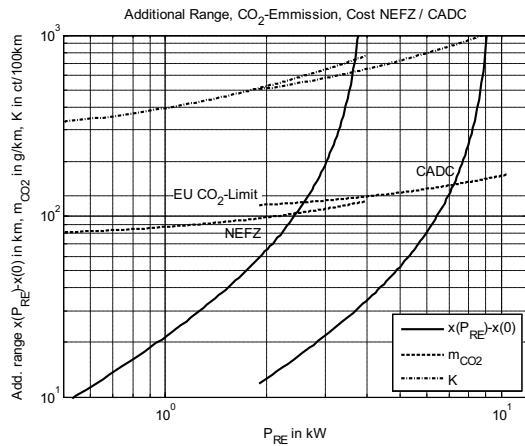


Figure 3: Additional range, CO₂-exhaust and cost depending on the RE power for
a) urban, rural and motorway operation
b) standard test cycles,

REFERENCES

- Staschus, K. 2007. *Auto-Stromnetz-Synergie spart Geld und CO₂*. Elektrizitätswirtschaft Nr. 21/2007
- André, M. 2004. *Real-world driving cycles for measuring cars pollutant emissions*, Part A: The ARTEMIS European driving cycles, Report INRETS-LTE 0411, June 2004.
- Powell, B.K.; Pilutti, T.E. 1994. *A Range Extender Hybrid Electric Vehicle Dynamic Model*. Proceedings of the 33rd Conference on Decision and Control, Lake Buena Vista, FL – December 1994.
- Richter, M.; Walter, S.; Stiegeler, M.; Mendes, M.; Kabza, H. 2011. *Route-dependent power-adapted operation strategies in range extender hybrid vehicles*. 14th European Conference on Power Electronics and Applications (EPE 2011), 2011 , p. 1 - 6
- Haubrock, A. 2011. *Degradationsuntersuchungen von Lithium-Ionen Batterien bei deren Einsatz in Elektro- und Hybridfahrzeugen*. Dissertation Thesis, IEE, TU Clausthal, 2011.
- Mischke, M.; Wallentowitz, H. 2004. *Dynamik der Kraftfahrzeuge*. Springer-VDI-Verlag, 4. Auflage 2004.
- Schramm, D.; Hiller, M.; Bardini, R. 2011. *Modellbildung und Simulation der Dynamik von Kraftfahrzeugen*. Springer-Verlag, 2011.
- Schröder, D. 2005 *Elektrische Antriebe Bd 2 Regelung von Antrieben*. Springer-Verlag, Berlin Heidelberg, 2005.
- Umweltbundesamt. 2011. *Entwicklung der spezifischen Kohlendioxid-Emissionen des deutschen Strommix im Vergleich zu CO₂-Emissionen der Stromerzeugung 1990-2009 und erste Schätzung 2010*; <http://www.umweltbundesamt.de/energie/archiv/co2-strommix.pdf>.