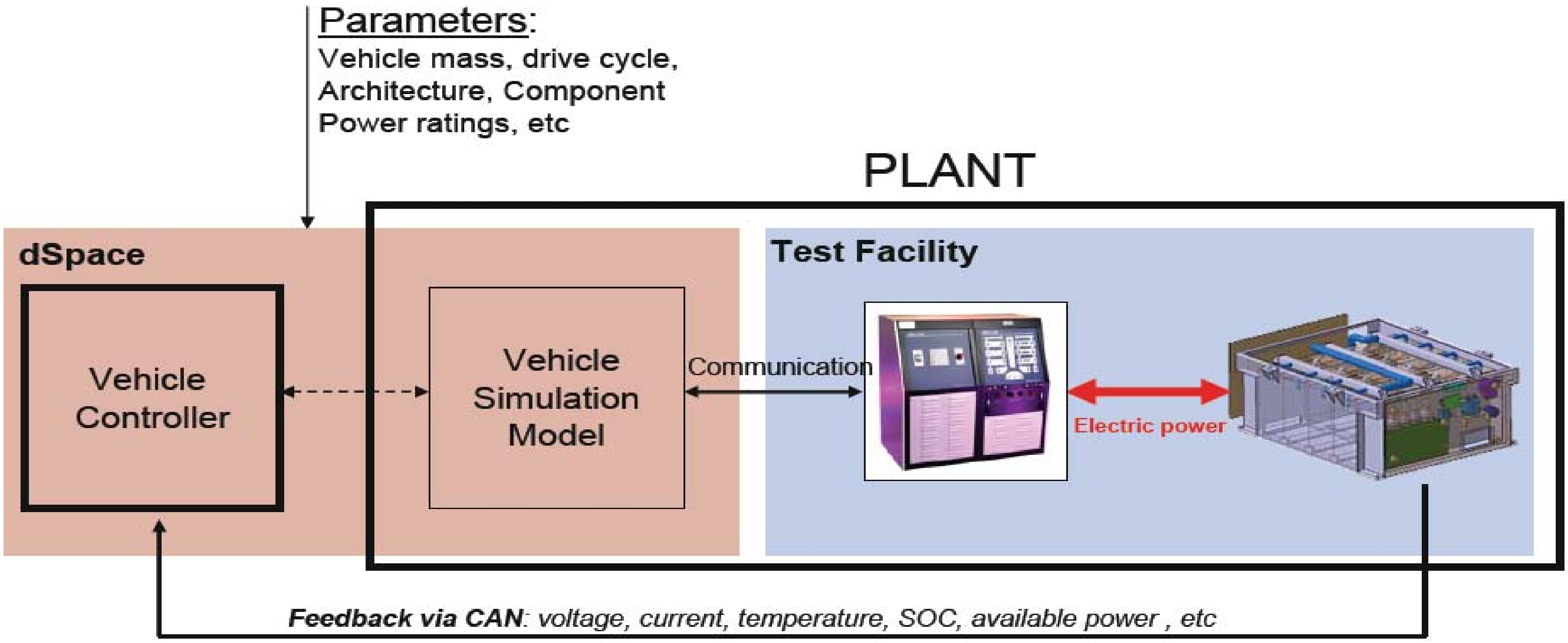
Round-trip efficiency calculations using Battery HIL

Neeraj Shidore, Ted Bohn

nshidore@anl.gov

Battery Hardware in the Loop

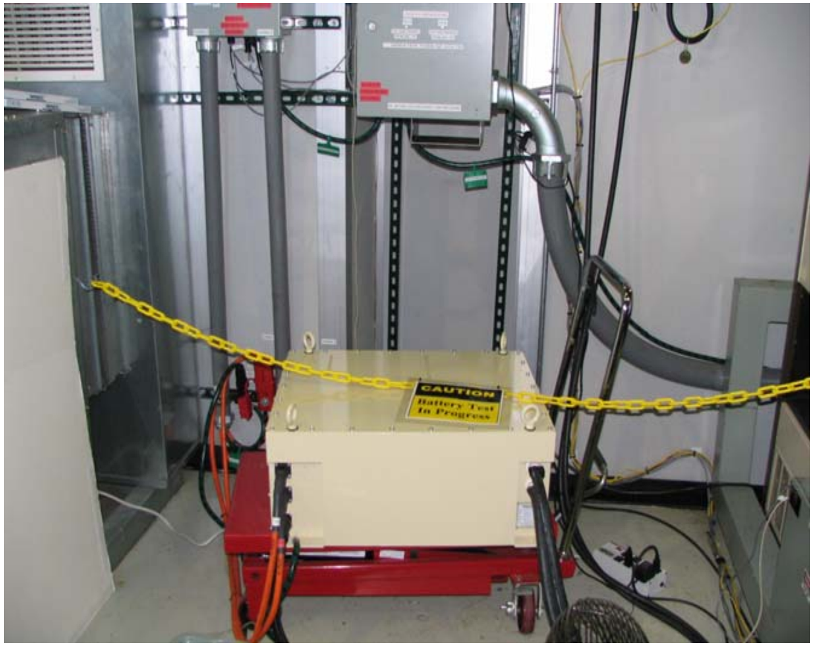
The JCS VL41M battery is being evaluated in a (vehicle) systems context using battery HIL



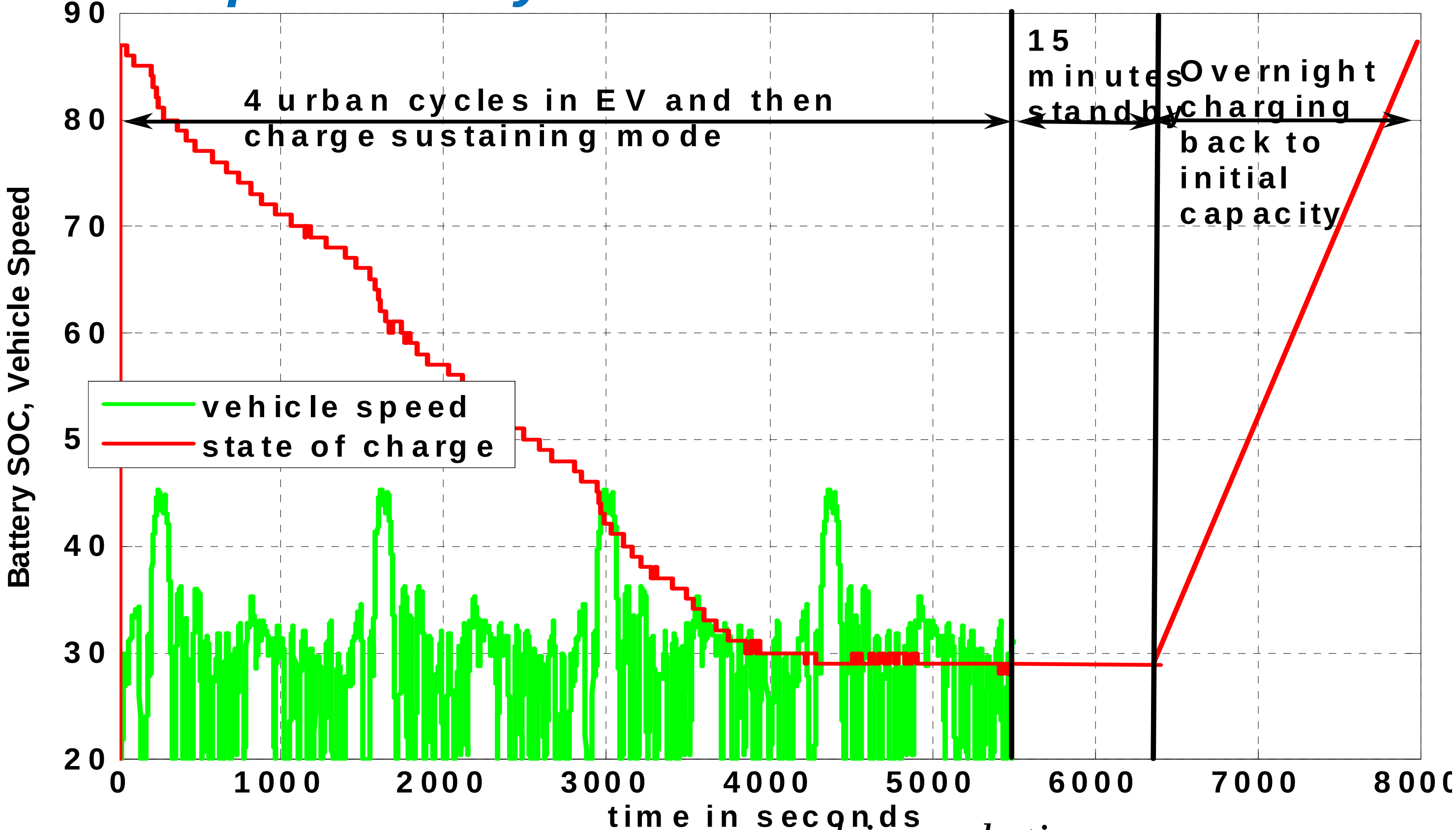
Battery HIL concept

Virtual Vehicle

Real Battery – SAFT VL41M



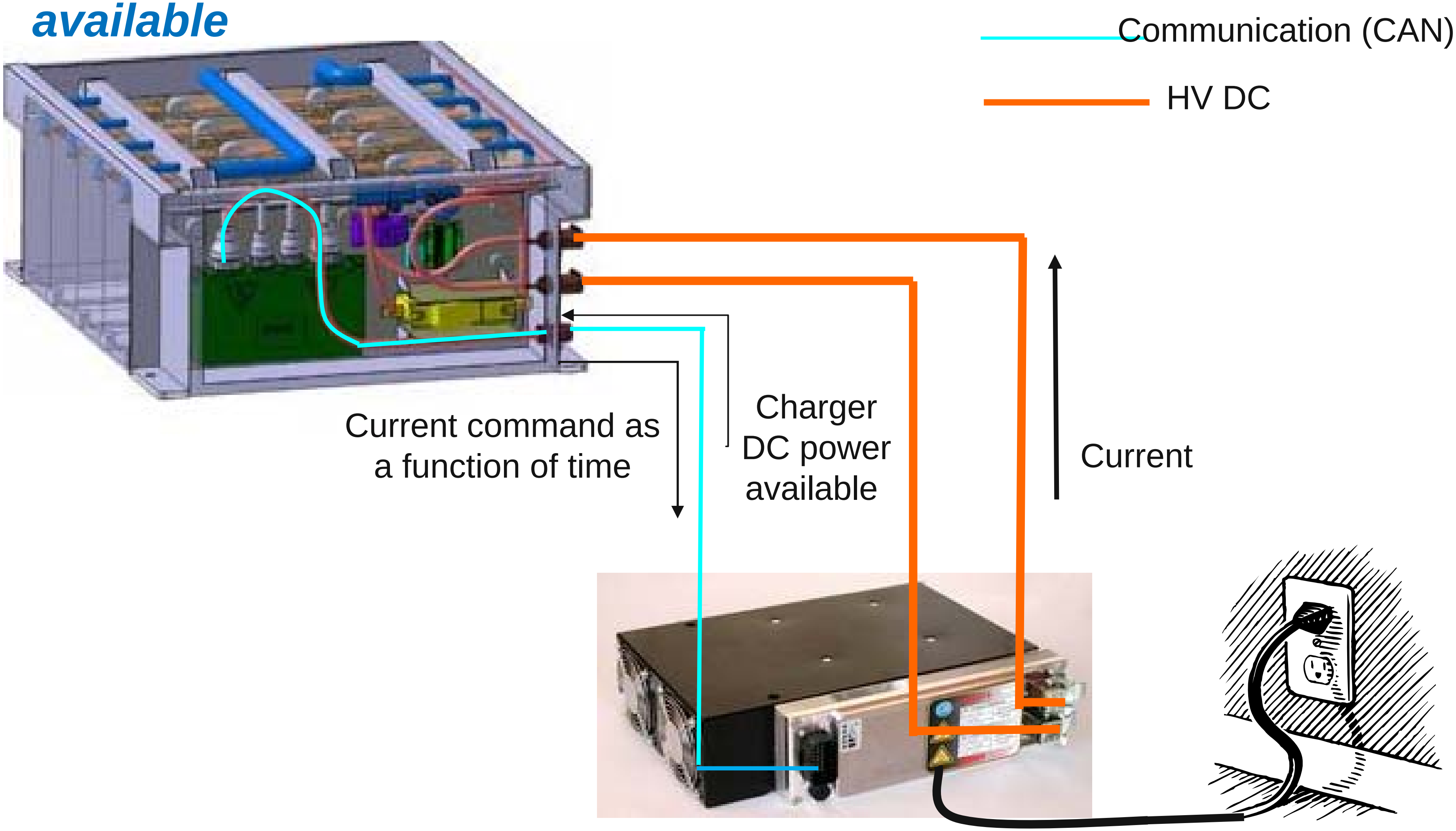
Round trip efficiency Calculations



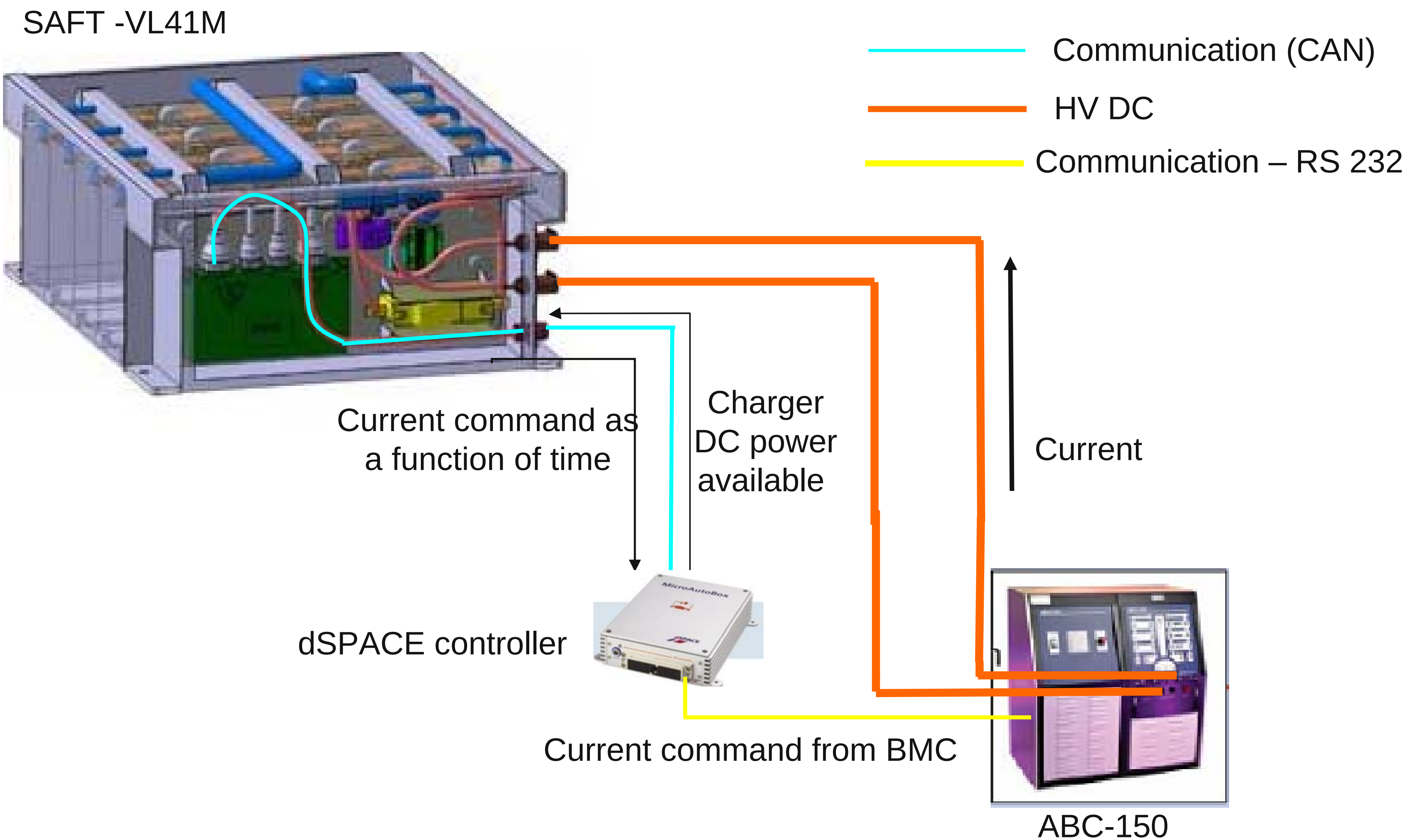
$$\text{Roundtrip battery efficiency} = \frac{\int_{0}^{\textit{drivecycle time}} Vb * Ib \, dt}{\int_{0}^{\textit{overnight charge time}} Vb * Ib \, dt}$$

Vb,Ib measured at Battery terminals

Battery charging current profile decided by Battery Management controller based on charger DC power available



Battery charging on the BHIL set-up using the ABC-150



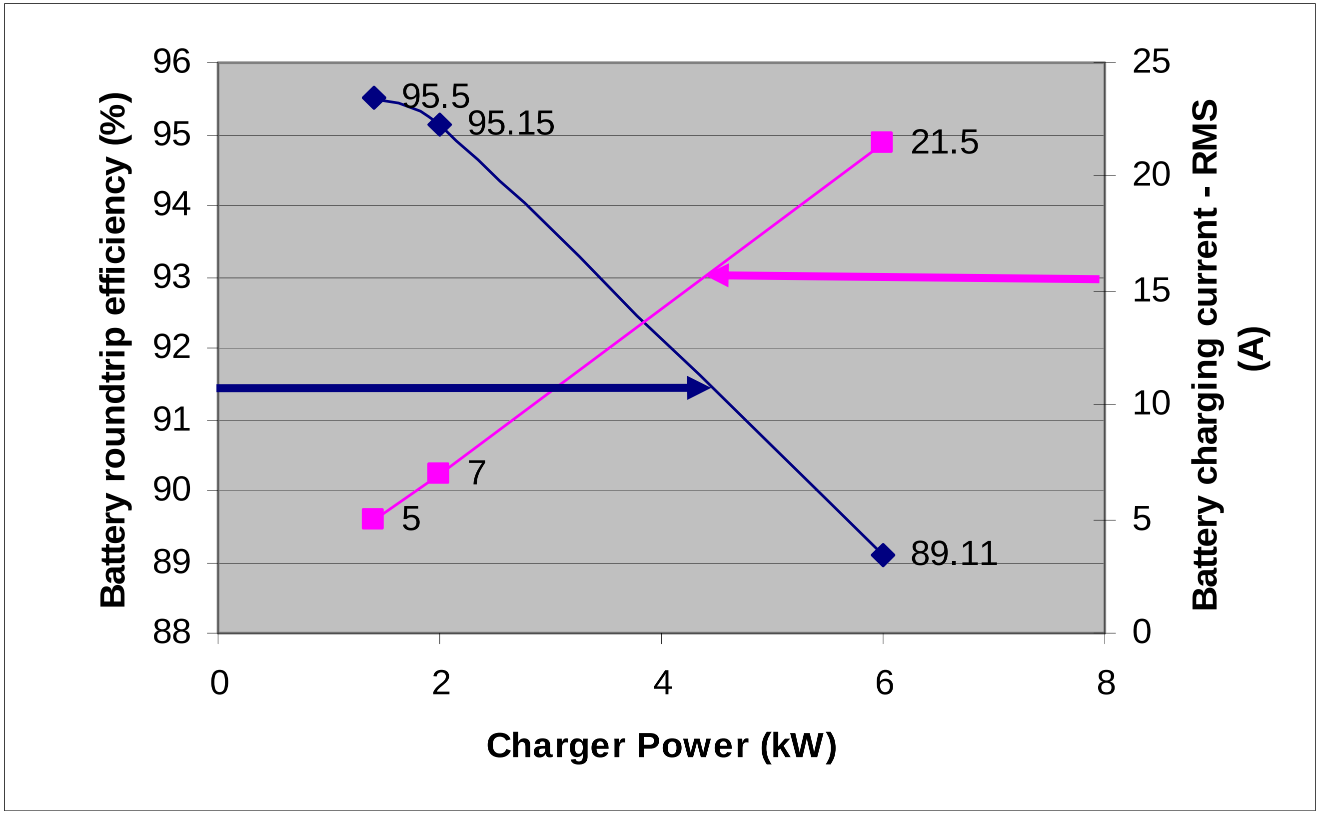
Vehicle specifications and assumptions on charger DC power available to the battery

- Certain DC power is assumed based on 3 possible AC ratings of the charger
- This assumption does not affect battery round trip efficiency calculations

Charger AC power rating	Assumption on DC power available
120 V AC, 15 Amp	1.4 kW
120 V AC,20 Amp	2 kW
208/240 V AC, 30 Amp	6 kW

Vehicle class/configuration	Midsize, pre-transmission parallel
Vehicle Mass	1665 kg/3670 lb
Electric machine	75 kW peak power
Plug-in modes	EV mode until 30% SOC, charge sustaining at 30% SOC

Battery roundtrip efficiency as a function of charger DC power



$$\eta = \frac{\text{battery energy discharged over the cycles}}{\text{battery energy discharged over the cycles} + \text{charging i.e. } I^2 R \text{ losses}}$$

Battery charging time as a function of charger power