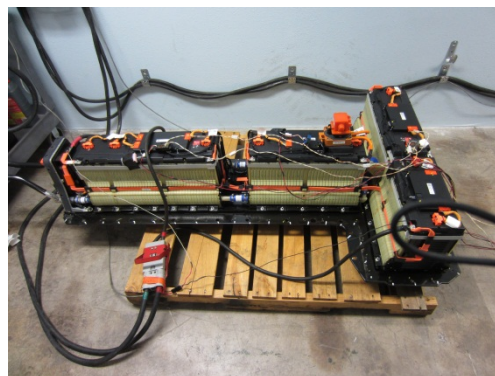


2013 Chevrolet Volt – VIN 3929

Advanced Vehicle Testing – Beginning-of-Test Battery Testing Results



VEHICLE DETAILS AND BATTERY SPECIFICATIONS¹

Vehicle Details

Base Vehicle: 2013 Chevrolet Volt
 VIN: 1G1RA6E40DU103929
 Propulsion System: Multi-Mode PHEV (EV, Series, and Power-split)
 Engine: DOHC I-4, 1.4 L, 63 kW @ 4800 rpm
 Number of Electric Machines²: 2
 Motor: 111 kW (peak), AC induction, Air cooled
 Generator²: 55 kW (peak), DC Permanent Magnet, Liquid cooled
 Peak Electric Drive and Engine Power: 111 kW

Battery Specifications

Manufacturer: LG Chem
 Type: Lithium-ion
 Number of Cells: 288
 Nominal Cell Voltage: 3.7 V
 Nominal System Voltage: 355.2 V
 Rated Pack Capacity: 45 Ah
 Rated Pack Energy: 16.5 kWh
 Maximum Cell Charge Voltage³: 4.15 V
 Minimum Cell Discharge Voltage³: 3.00 V
 Thermal Management: Active – Liquid cooled

BATTERY LABORATORY TEST RESULTS SUMMARY

Vehicle Mileage and Testing Date

Vehicle Odometer: 4,007 mi
 Date of Test: December 13, 2012

Static Capacity Test

Measured Average Capacity: 46.5 Ah
 Measured Average Energy Capacity: 16.6 kWh

HPPC Test

CD Available Energy Margin⁴: 1.1 kWh
 CS Available Energy Margin⁴: 0.89 kWh

Constant-Power Discharge Test

Capacity Discharged: 46.7 Ah
 Energy Discharged: 16.7 kWh

NOTES:

1. Vehicle details and battery specifications were either supplied by the manufacturer or derived from a literature review.
2. Not all electric machines (EMs) always provide traction power; one of the EMs is a traction motor while the main role of the other is to act as a generator.
3. Maximum cell charge voltage and minimum cell discharge voltage are based on similar battery chemistries from the same battery manufacturer.
4. Available energy at the DOE maximum PHEV power performance goals.

Test Results Analysis

Test results for the beginning-of-testing (BOT) battery testing are provided herein. Battery test results include those from the Static Capacity Test and the Hybrid Pulse Power Characterization (HPPC) Test, based on recommended test procedures from the United States Advanced Battery Consortium (USABC) at the time of testing.

Static Capacity Test Results

Static capacity test results are summarized in the fact sheet on the previous page. The test was performed on December 13, 2012 with a vehicle odometer reading of 4,007 miles. The average measured C/3-rate capacity was 46.5 Ah compared with the manufacturer's rated capacity of 45.0 Ah. The average measured energy capacity was 16.6 kWh.

Figure 1 is a graph of battery voltage versus energy discharged. This graph illustrates the voltage values during the constant-current discharge versus the cumulative energy discharged from the battery at a C/3 discharge rate.

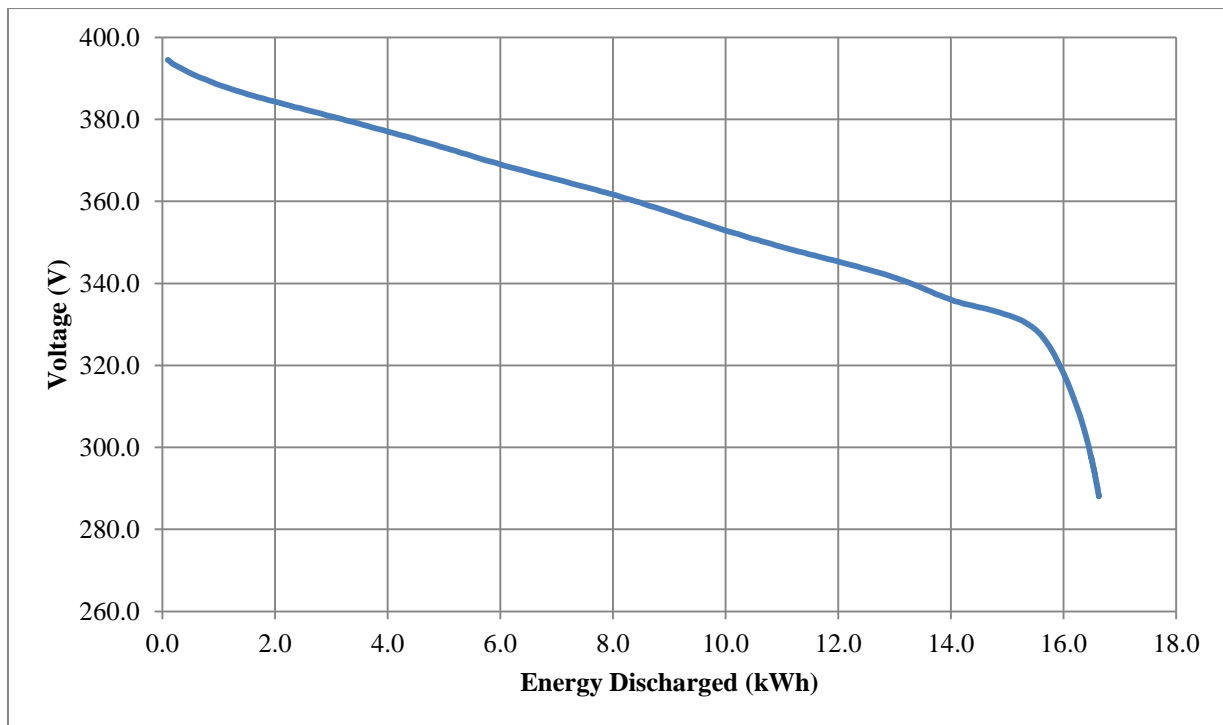


Figure 1: Voltage vs. Energy Discharged

HPPC Test Results

HPPC test results are summarized in the fact sheet on the first page. The peak pulse discharge power is 240.4 kW at 50% depth of discharge (DOD). The peak pulse charge power is 150.4 kW at 50% DOD. The maximum and minimum cell voltages used for this analysis were 4.15 V and 3.00 V, respectively.

Figures 2 and 3 illustrate the battery's charge and discharge pulse resistance graphs which show internal resistance at various DOD. Each curve represents the resistance calculated at the end of the specified pulse interval.

Figures 4 and 5 illustrate the battery's charge and discharge pulse power graphs which show the power capability at various DOD. Each curve represents the pulse power calculated at the end of the specified pulse interval at the cell voltage limits.

Figure 6 is a plot of the battery's HPPC 10-second pulse power as a function of energy discharged. The graph shows the power values over the energy discharged range, as well as the DOE Maximum PHEV battery target performance goals of 38 kW discharge power and 25 kW regenerative power. The Volt battery meets the DOE power performance goals for any battery state of charge.

Figure 7 is a plot of the battery's charge-depleting (CD) and charge-sustaining (CS) useable energies as a function of discharge power. The x-axis indicates a desired discharge power level and the y-axis indicates the useable energy at that power. The two dashed horizontal lines show the DOE Maximum PHEV energy performance goals for CS and CD mode of 0.3 kWh and 11.6 kWh, respectively. The dashed vertical line shows the DOE Maximum PHEV charge-sustaining power performance goal of 38 kW. The 2013 Chevrolet Volt battery's useable energy curve falls above and to the right of the both intersections of the DOE energy performance goals and the power performance goal. The maximum power that can be delivered while meeting the DOE energy performance goal for charge-sustaining mode is 155 kW at 300 Wh. The CD available energy at the DOE power performance goal is 12.7 kWh, exceeding the target of 11.6 kWh by a margin of 1.1 kWh. The CS available energy at the DOE power performance goal is 1.19 kWh, exceeding the target of 0.3 kWh by a margin of 0.89 kWh. This indicates that at the time of testing, the Volt battery performance was above the DOE Maximum PHEV battery performance goals.

These tests were performed for DOE's Advanced Vehicle Testing and Evaluation (AVTE). The AVTE, part of DOE's Vehicle Technology Program, is conducted by the Idaho National Laboratory and Electric Transportation Engineering Corporation dba ECotality North America.

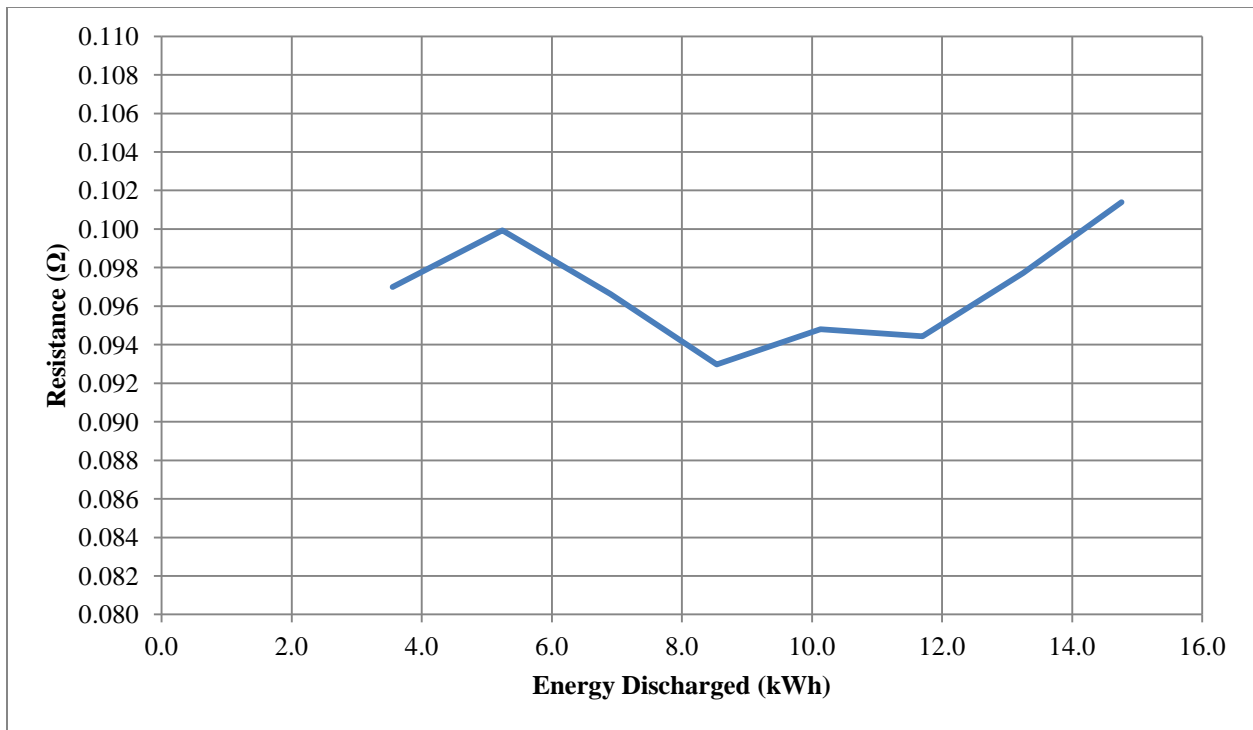


Figure 2: Charge Pulse Resistance vs. Energy Discharged

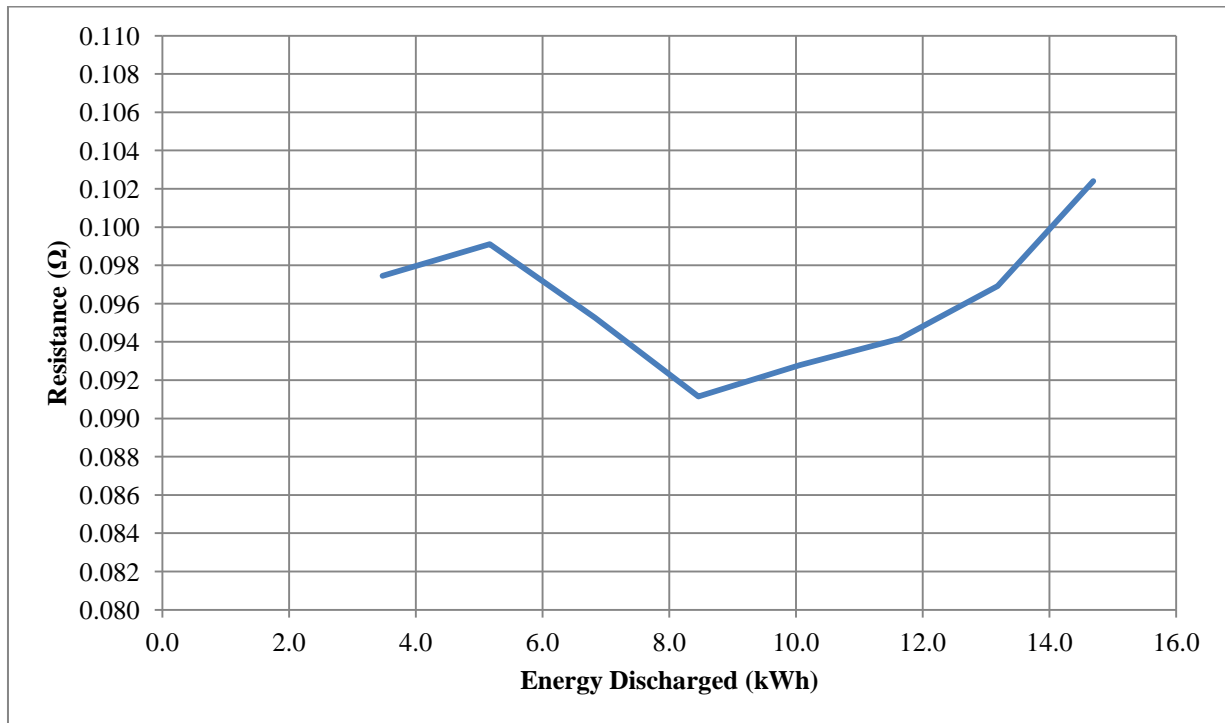


Figure 3. Discharge Pulse Resistance vs. Energy Discharged

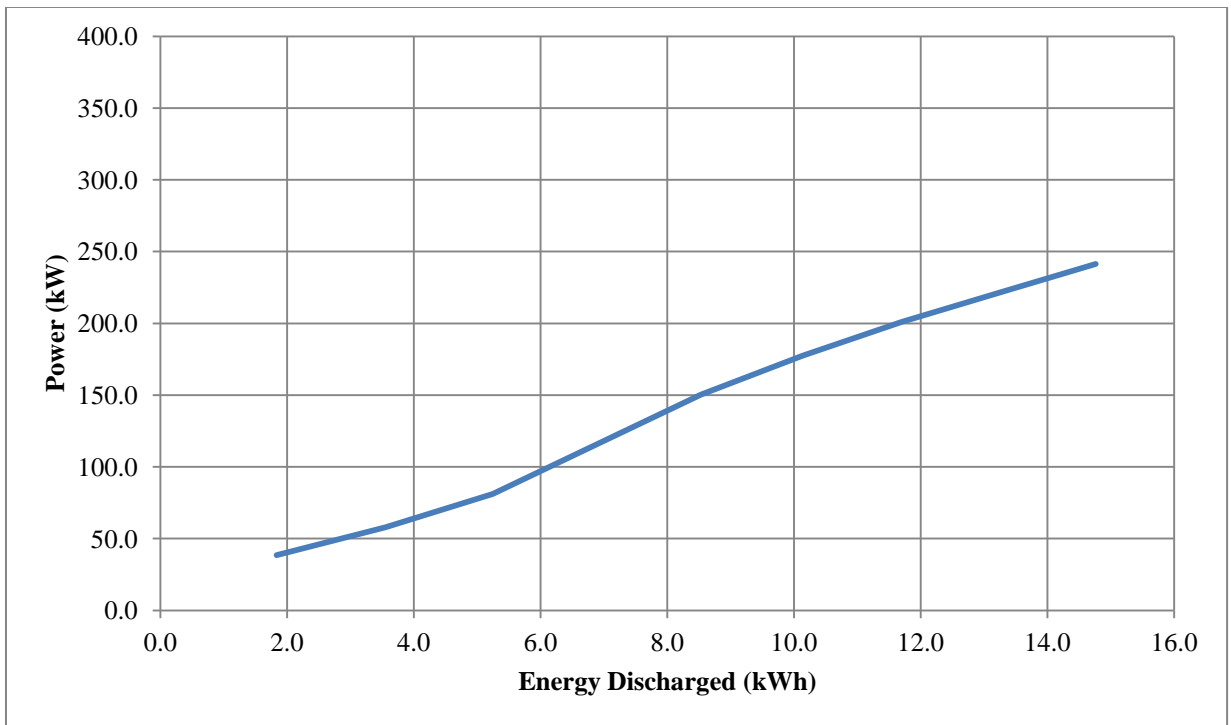


Figure 4. Charge Pulse Power Capability vs. Energy Discharged

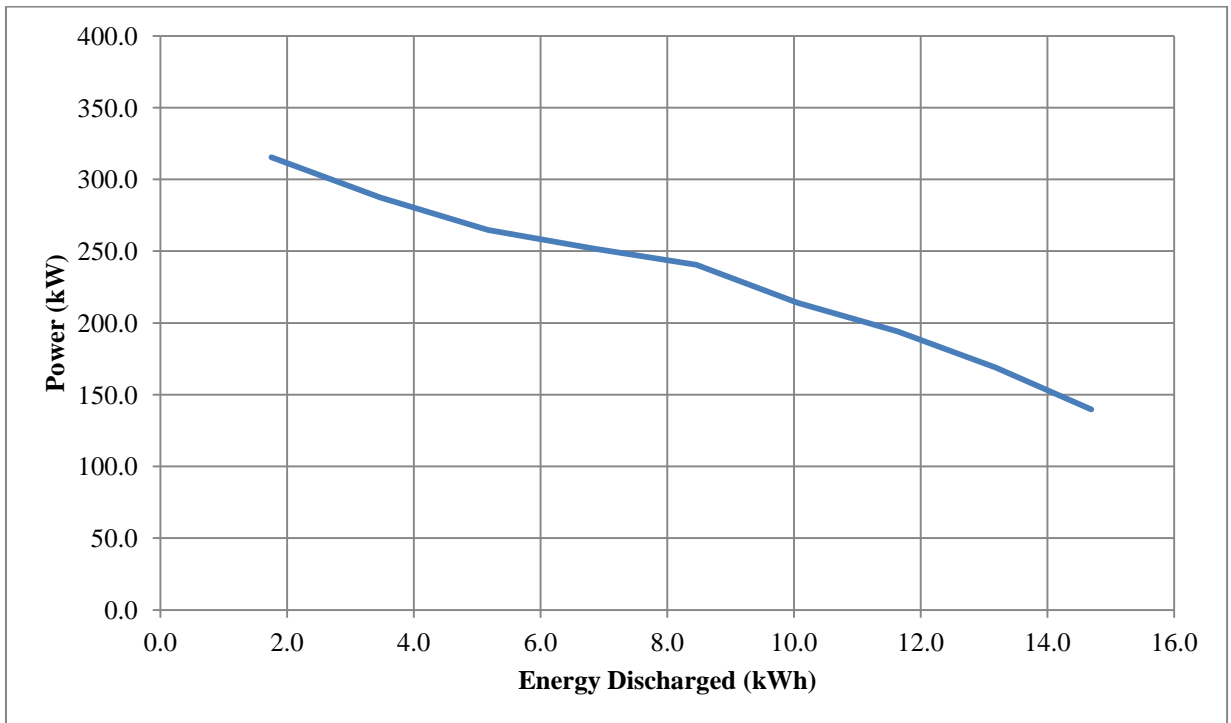


Figure 5. Discharge Pulse Power Capability vs. Energy Discharged

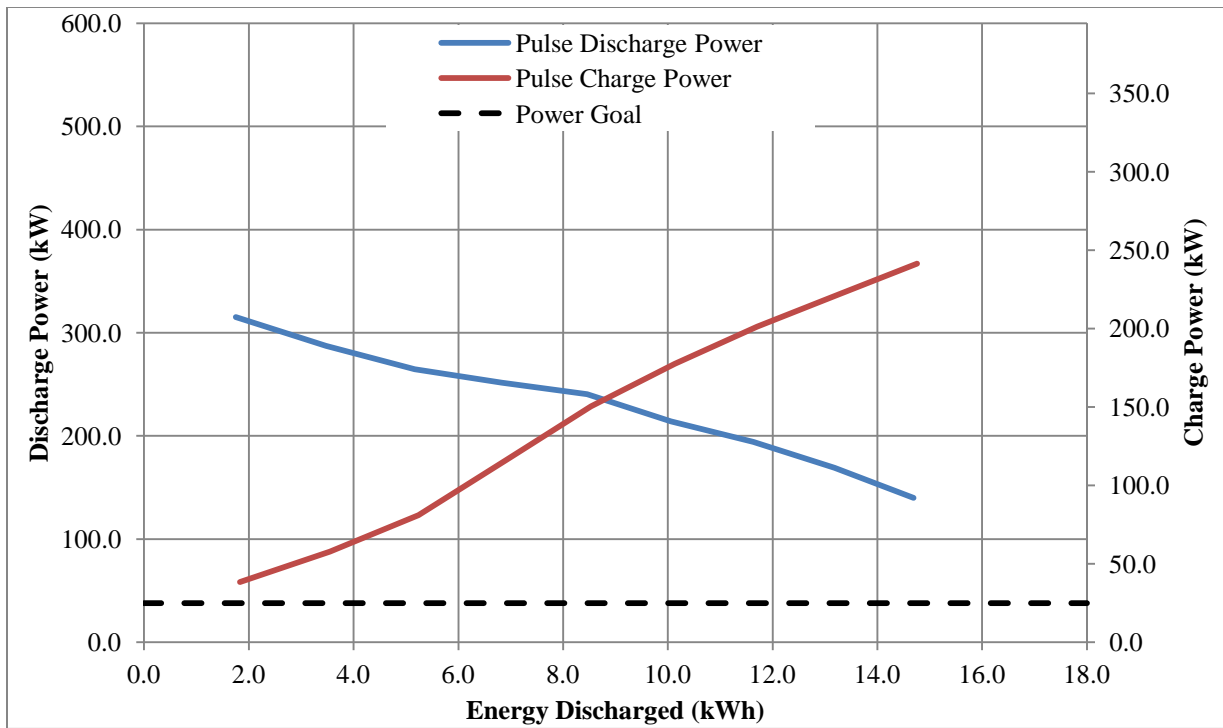


Figure 6. Charge and Discharge Peak Power Values

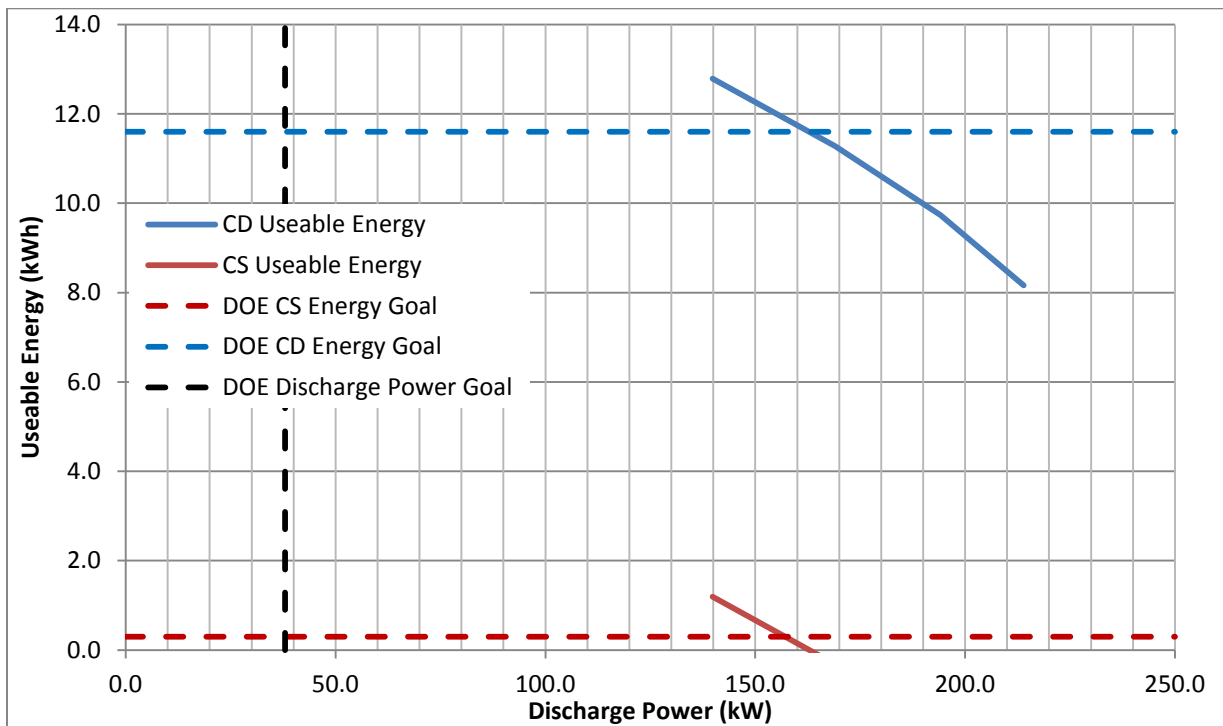


Figure 7. Useable Energy vs. Power