



2005 Ford Escape-5881 Hybrid Battery Test Results

HEVAMERICA
U.S. DEPARTMENT OF ENERGY ADVANCED VEHICLE TESTING ACTIVITY



Hybrid System Specifications

Battery Specifications

Manufacturer: Sanyo Electric Co.
Battery Type: Nickel Metal Hydride
Rated Capacity: 5.5 Ahr
Rated Power: N/A
Nominal Pack Voltage: 330.0 VDC
Nominal Cell Voltage: 1.32 V
Number of Cells: 250

Vehicle Specifications

Manufacturer: Ford
Model: Escape
Year: 2005
Number of Motors¹: 1
Motor Power Rating²: 70 kW
VIN #: 1FMYU95H75KC45881

Battery Lab Test Results

HPPC Test

Peak Pulse Discharge Power @ 10s³: 24.9 kW
Peak Pulse Discharge Power @ 1s³: 35.3 kW
Peak Pulse Charge Power @ 10s³: 24.2 kW
Peak Pulse Charge Power @ 1s³: 35.8 kW
Maximum Cell Charge Voltage: 1.5 V
Minimum Cell Discharge Voltage: 1.0 V

Static Capacity Test

Measured Average Capacity: 5.19 Ah
Measured Average Energy Capacity: 1650 Wh

Vehicle Mileage and Testing Date

Vehicle Odometer: 160,347 mi
Date of Test: August 4, 2007

Analysis Notes:

1. Motor refers to any motor capable of supplying traction power.
2. Motor power rating refers to the manufacturer's peak power rating for the motor(s) supplying traction power.
3. Calculated value based on selected battery voltage limits and at 50% SOC.

Test Results

Test results for the end-of-life battery testing are provided herein. Battery test results include those from the Static Capacity Test and the Hybrid Pulse Power Characterization (HPPC) Test¹.

Static Capacity Test Results

Static capacity test results are summarized in the fact sheet. The test was performed on August 4, 2007 with a vehicle odometer reading of 160,347 miles. The measured average C/1-rate capacity was 5.19 Ah compared with the manufacturer's rated capacity of 5.5 Ah. The measured average energy capacity was 1650 Wh.

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/1 discharge rate.

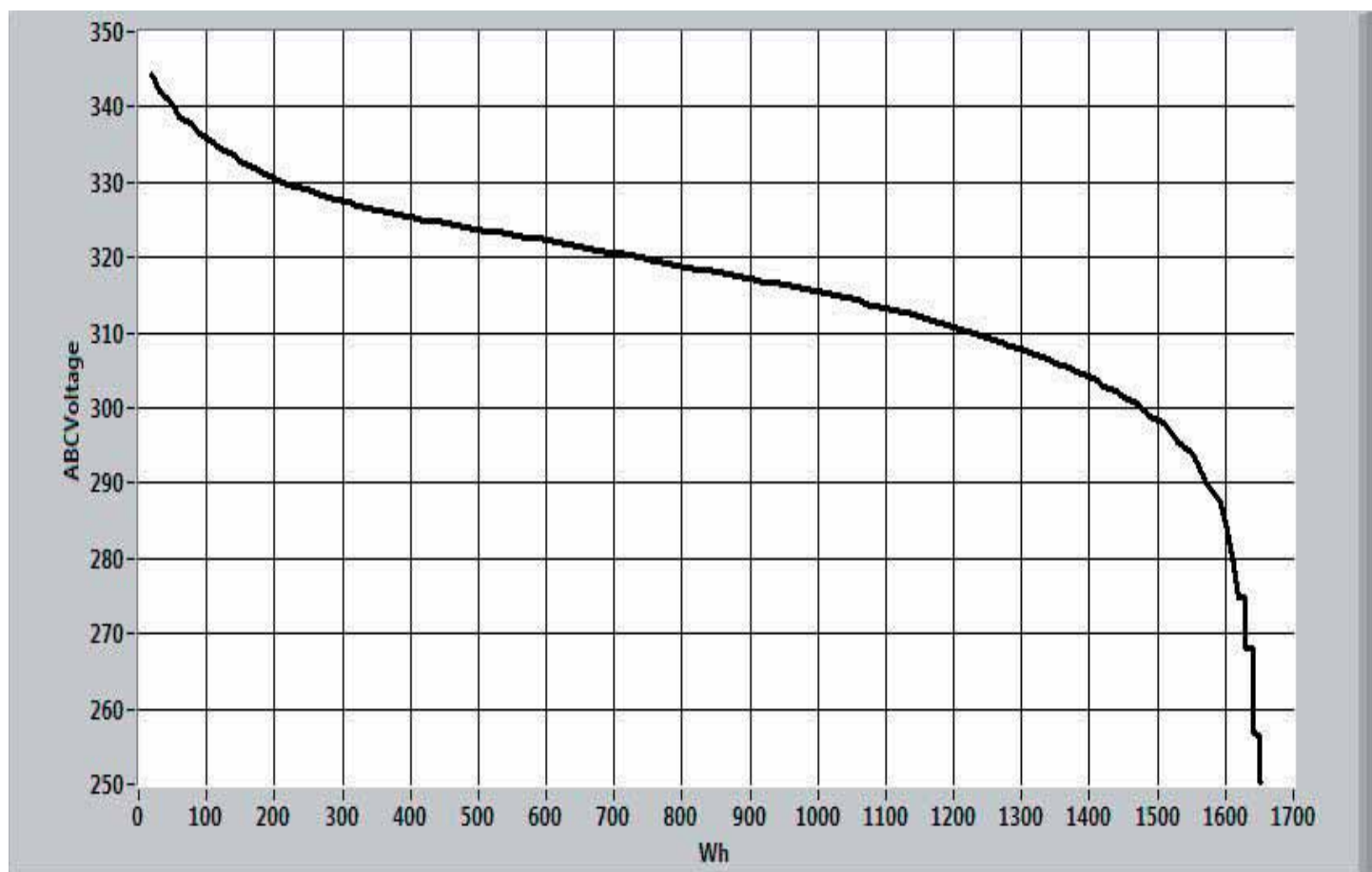


Figure 1
Voltage vs. Energy Discharged

1. Static Capacity and Hybrid Pulse Power Characterization test procedures were performed in accordance with FreedomCAR Battery Test Manual for Power-Assist Hybrid Vehicles, DOE/ID-11069, October 2003 procedures 3.2 and 3.3 respectively.

HPPC Test Results

HPPC test results are summarized in the fact sheet. The peak pulse discharge power at 10 seconds and 1 second into the pulse are 24.9 kW and 35.3 kW at 50% SOC respectively. The peak pulse charge power at 10 seconds and 1 second into the pulse are 24.2 kW and 35.8 kW at 50% SOC respectively. The maximum and minimum cell voltages used for this analysis were 1.5 V and 1.0 V respectively.

Figures 2 and 4 illustrate the battery's charge and discharge pulse resistance graphs which show internal resistance at various depths of discharge. Each curve represents the resistance at the end of the specified pulse interval.

Figures 3 and 5 illustrate the battery's charge and discharge pulse power graphs which show the pulse power at various depths of discharge. Each curve represents pulse power 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 state of charge. The graph shows the power values over the range of state of charge as well as the DOE target performance goals of 25 kW discharge power and 20 kW regenerative power for a hybrid minimum power assist battery. The battery meets the DOE power performance goals for battery state of charge range of 85% to 48% at the time of testing.

Figure 7 is a plot of the battery's useable energy as a function of power. The x-axis indicates a desired discharge or charge power level and the y-axis indicates the useable energy at that power. The dashed horizontal line shows the DOE Minimum Power Assist HEV energy performance goal of 300 Wh. The dashed vertical line shows the DOE Minimum Power Assist power performance goal of 25 kW. The Escape battery's useable energy curve falls above and to the right of the intersection of the DOE energy and power performance goals. The maximum power that can be delivered while meeting the DOE energy performance goal is 26.5 kW at 300 Wh. The maximum energy that can be delivered while meeting the DOE power performance goals is 585 Wh at 25 kW. This indicates that at the time of testing, the Escape battery performance was above the DOE performance goals.

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

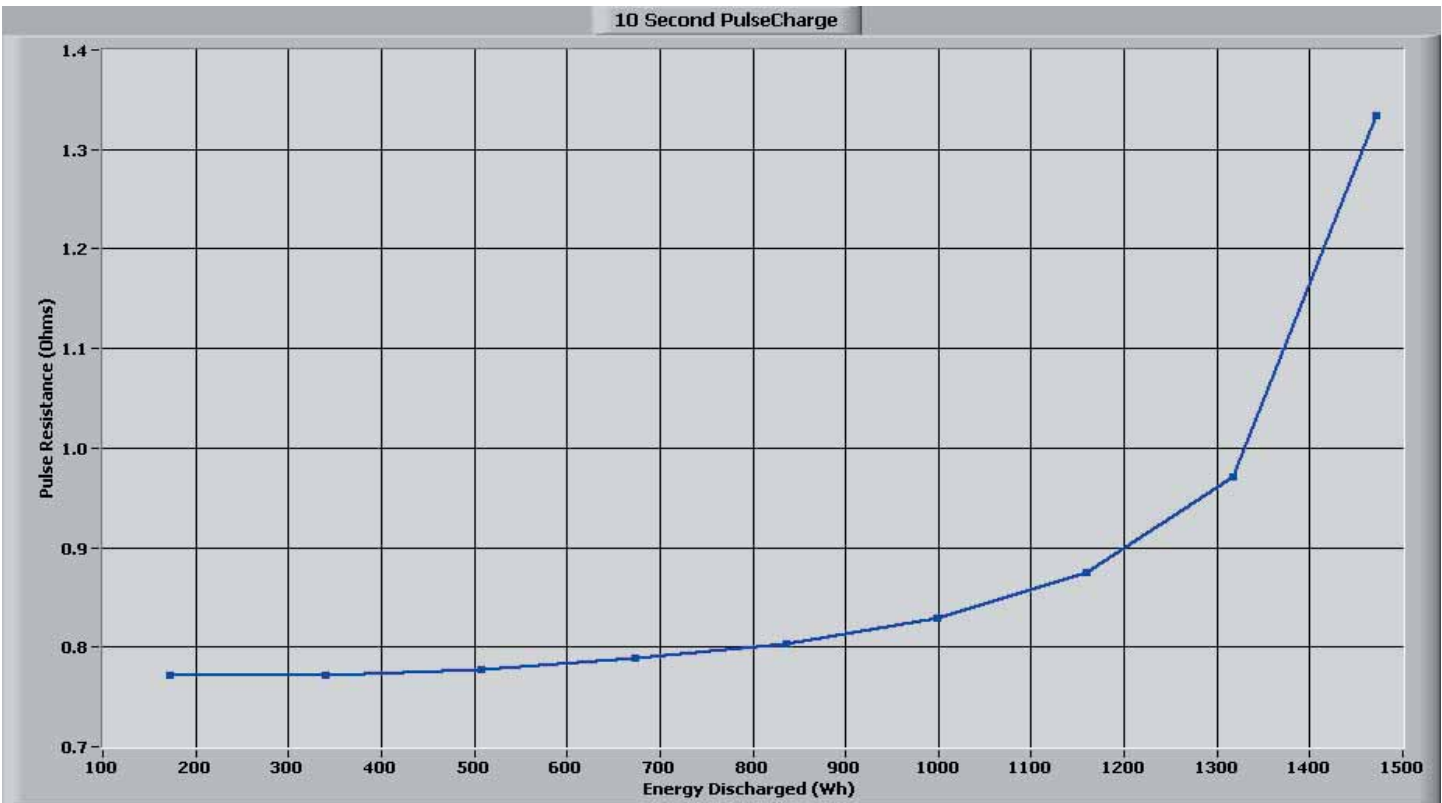


Figure 2
Charge Pulse Resistance vs. Energy Discharged



Figure 3
Charge Pulse Power vs. Energy Discharged



Figure 4
Discharge Pulse Resistance vs. Energy Discharged

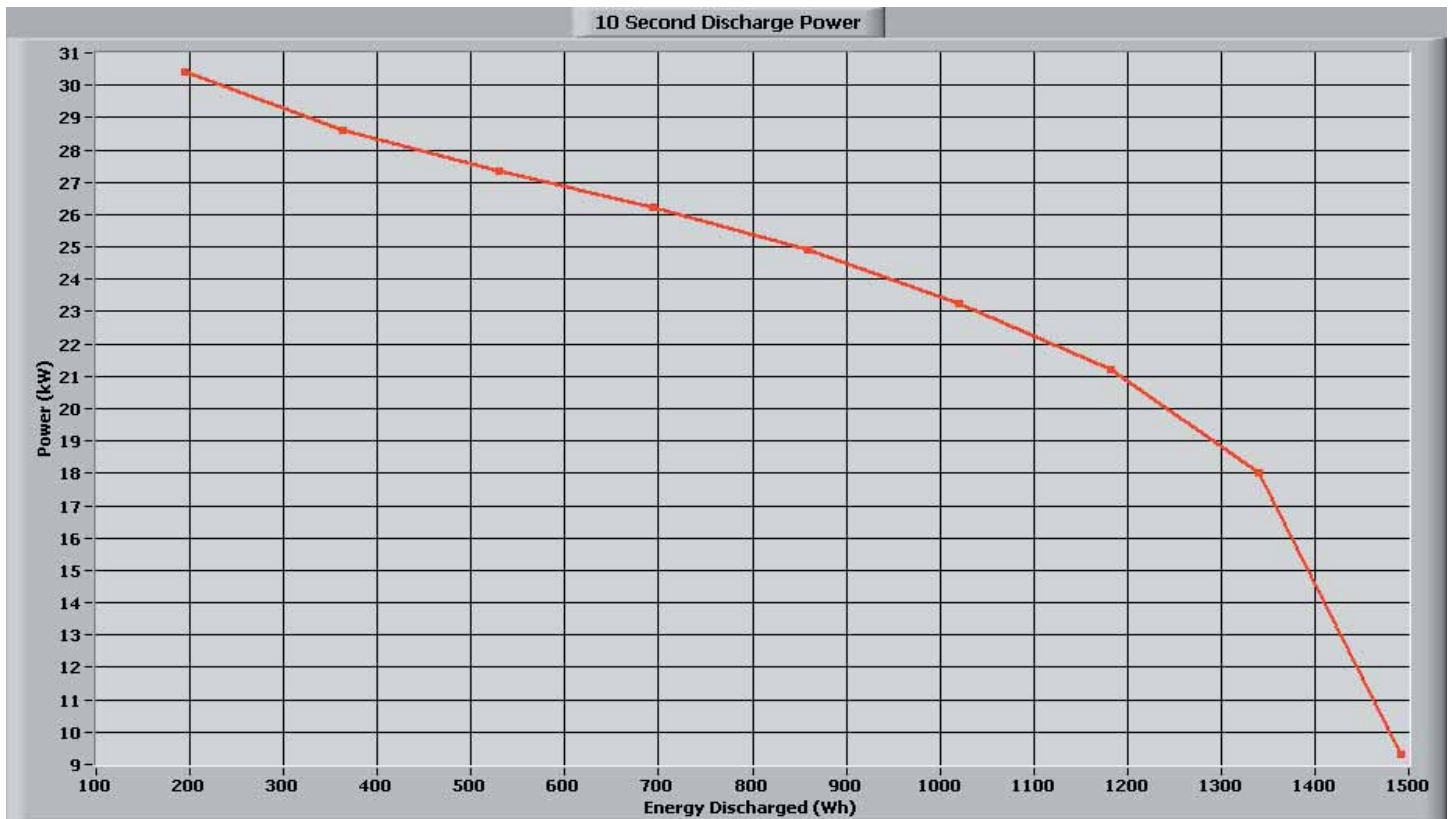


Figure 5
Discharge Pulse Power vs. Energy Discharged

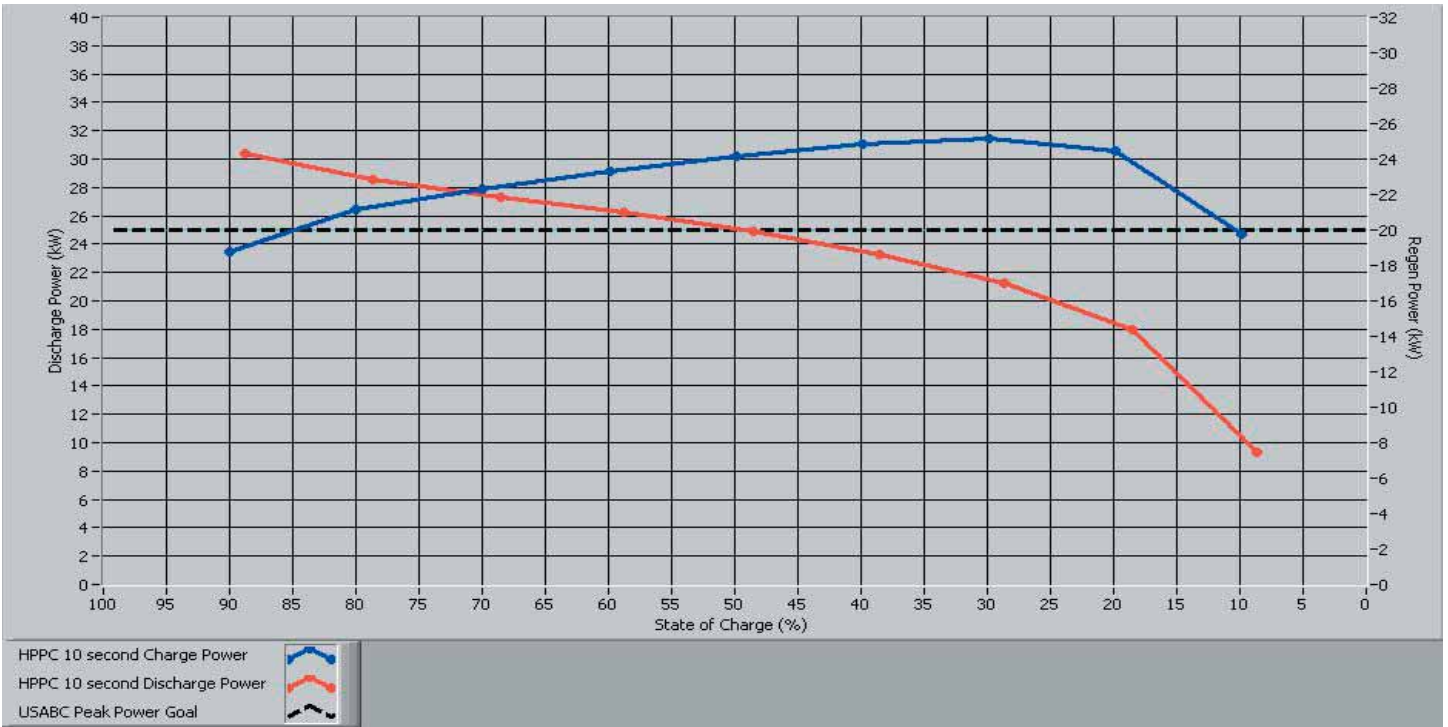


Figure 6
Peak Power Values with DOE Performance Goals

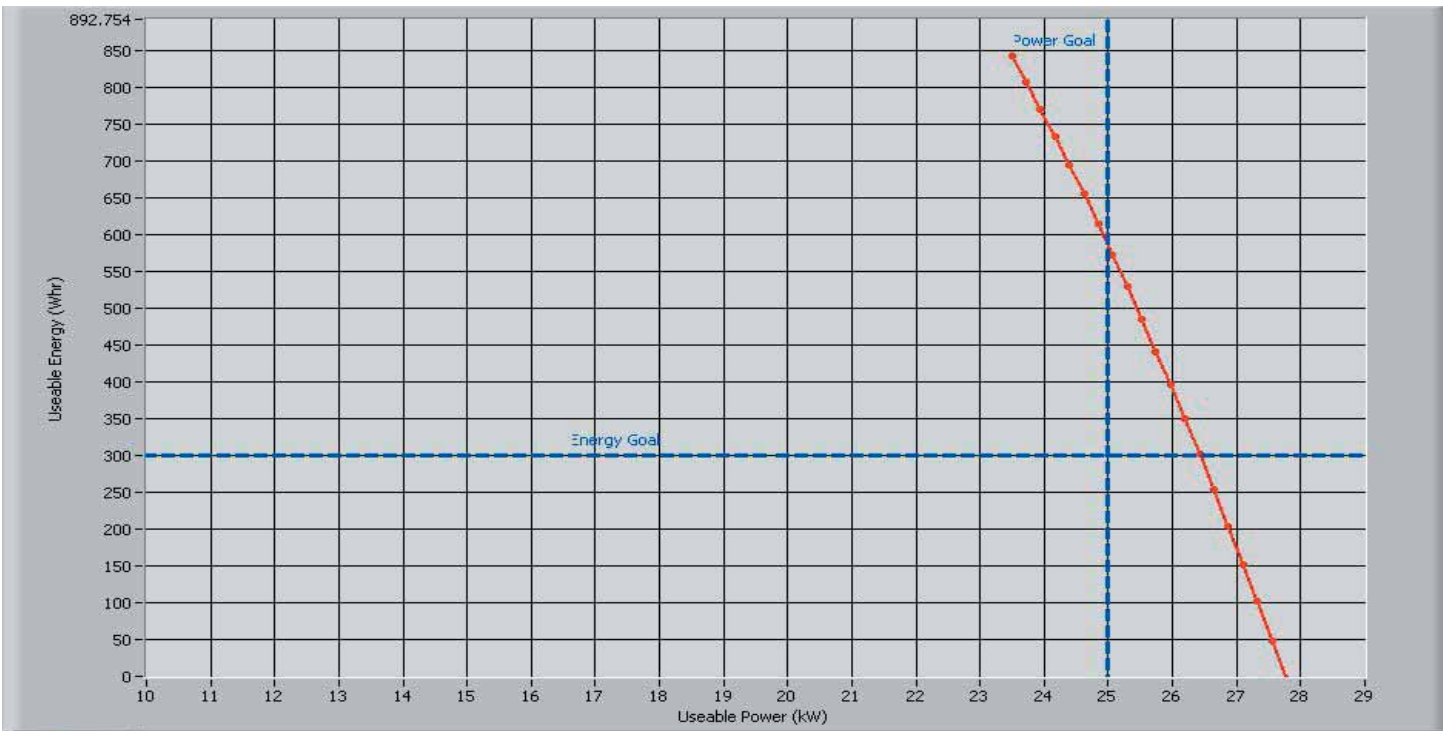


Figure 7
Useable Energy