CUSTOMER REPORT

VTT-CR-00391-26

Donut Battery V1.5 Energy Density Test

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Confidentiality: VTT Confidential

Version: 1.9.2026

Report's title Donut Battery V1.5 Energy Density Test	
Customer, contact person, address Donut Lab, Ville Piippo, Tallberginkatu 2 A 13, 00180 Helsinki	**Order reference**
Project name Solid-State Battery Performance Test 3	**Project number/Short name** 145863 / SSB Performance Test 3

Summary

The objective of this project was to conduct independent performance testing of energy storage devices supplied by the customer. The work reported herein focused on a Donut Battery V1.5 cell, designated DL6, for which the weight, dimensions, and capacity were measured to determine the gravimetric and volumetric energy densities.

Cell weight and dimensions were measured, and capacity was determined at an ambient temperature of +25 °C within the recommended voltage range using a 0.1C discharge rate. The measured gravimetric energy density was 409.3 Wh/kg, while the measured volumetric energy density was 804.7 Wh/L.

Espoo 1.9.2026

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Distribution (customer and VTT)

One copy to Customer, one copy to VTT registry

Approval

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1. Description and objectives

The objective of the project was to conduct independent performance testing of energy storage devices supplied by the customer. One cell was provided for testing and designated DL6. The provided cell was an energy-optimised variant of the V1 cell previously tested at VTT and was designated V1.5 to distinguish it from the earlier cell type. In the work reported herein, the gravimetric and volumetric energy densities of the cell were determined based on measurements of cell weight, dimensions, and capacity.

The specification of the device under test is presented in Table 1. The test described in this report was carried out in accordance with the customer's test plan. The tests were performed using a PEC ACT0550 cell tester, with the cell placed free-standing inside a climate test chamber. The test setup is shown in Figure 1. The specifications of the battery tester and the climate test chamber are presented in Table 2 and Table 3, respectively.

Table 1. Preliminary specification of the device under test, as provided by the customer.

Type of cell	Donut Battery V1.5
Recommended voltage	2.3–4.25 V

Table 2. Specification of the battery tester.

Product	PEC ACT0550 cell tester, 80 channels
Output voltage	0–5 VDC
Voltage measurement accuracy	0.005% FSD
Voltage measurement resolution	1.9 µV
Automatically switched current ranges	0–50 mA, 50–500 mA, 0.5–5 A, 5–50 A
Current measurement accuracy	0.03% FSD (each current range)
Current measurement resolution	8 µA

Table 3. Specification of the climate test chamber.

Product	Weiss LabEvent T/110/40/3
Test space volume nominal	110 litres
Test space dimensions H x W x D	630x560x350 mm
Temperature range	-40 °C to +180 °C
Average temperature rate	3.5 K/min
Temperature deviation in time	±0.2 K to ±0.5 K
Temperature homogeneity	±0.5 K to ±1.5 K

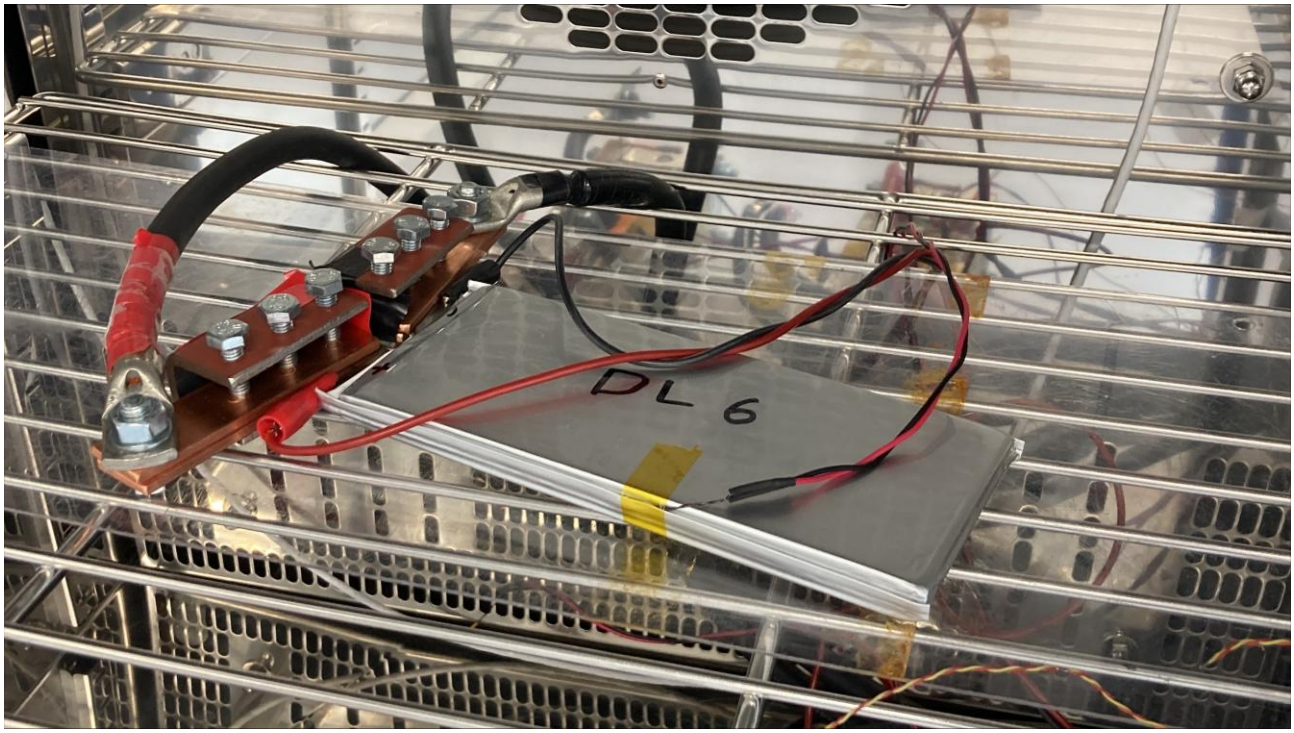

Figure 1. Test setup showing the cell positioned inside the climate test cabinet, with a temperature sensor attached under the folded seam on the side of the cell.

2. Methods

2.1 Capacity tests at +25 °C

Start: The temperature setpoint of the climate test chamber was set to +25 °C. After a two-hour idle period, the cell was charged at a rate of 0.1C until the highest recommended voltage of 4.25 V was reached, followed by constant-voltage charging at 4.25 V until the current decreased to 0.05C.

Cycles 1–2 (Capacity Test at +25 °C using a rate of 0.1C): After a one-hour idle period, the cell was discharged at a rate of 0.1C until the low cut-off voltage of 2.3 V was reached. After a one-hour idle period the cell was charged at a rate of 0.1C until the highest recommended voltage of 4.25 V was reached, followed by constant-voltage charging at 4.25 V until the current rate decreased to 0.05C. This cycle was repeated two times in total.

Before the test was stopped, the cell was discharged to approximately 50 % SOC using a discharge rate of 0.1C.

2.2 Weights and volumes of the cell

The weight and volume of the cell was measured. Cell weight was determined using a Precisa BJ 4100D digital scale, and the dimensions were measured using a digital calliper. The reported volume corresponds to the rectangular prism that accommodates the cell pouch with folded side seams and without the tabs in accordance with Annex B of IEC 62902:2025.

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3. Results

3.1 Capacity tests at +25 °C

All test cycles were successfully completed as specified in the Methods section. According to visual inspection, the cell did not swell or transform in any way during the test.

3.2 Gravimetric and volumetric energy densities

Gravimetric and volumetric energy densities were calculated based on the results of the second discharge in the capacity test and the measured cell dimensions and weight. The gravimetric and volumetric energy densities determined from this discharge were 409.3 Wh/kg and 804.7 Wh/L, respectively.

4. Conclusions and summary

This project included independent energy density measurements of the energy storage devices supplied by the customer. Cell weight and dimensions were measured, and cell capacity was determined at an ambient temperature of +25 °C within the recommended voltage range using a 0.1C discharge rate.

Based on the measured weight, dimensions, and capacity, the gravimetric energy density was determined to be 409.3 Wh/kg, and the volumetric energy density was determined to be 804.7 Wh/L.