

Hybrid Fuel Cell - Battery Research System

Using the Hybrid Energy Lab System (HEL)

The HEL gives users the opportunity to research & understand battery & fuel cell behaviour under various conditions.

Examine and control system functionality during charge and discharge cycles, and experiment with various types of hybridization set-ups while performing extensive data acquisition, analysis and visualization.

Includes set-ups for uninterruptible power supply, autonomous power supply, back-up power systems and hybrid electric vehicles.

Training & Research Topics

Battery Charging/Discharging

- Data acquisition of battery operating behavior while charging & discharging
- Charging & discharging profiles: e.g. Constant current (CC), constant voltage (CV), programmable user profiles.
- Charging via DC/DC Converter and Discharging via Electronic Load

Battery Model Analysis & Comparison

- Data fitting of model parameters
- State of Charge (SoC) vs. Battery Voltage
- Evaluation of user generated equivalent circuit models

Calculation & Evaluation of Electrical Characteristics

- Data acquisition of Internal Resistance & Temperature,
- Calculation of State of Charge (SoC), Capacity (Ah) & State of Health (SoH)
- Peukert Coefficients
- Storage efficiency (energy balance of charging and discharging)

Fuel Cell – Battery Hybrids

- Applications Set-ups: Backup, Uninterrupted Power Supply, Autonomous Power Supply, Supply for Power Burst, Recuperated Power
- Calculation of system efficiency & plotting of characteristic curves

Energy Management

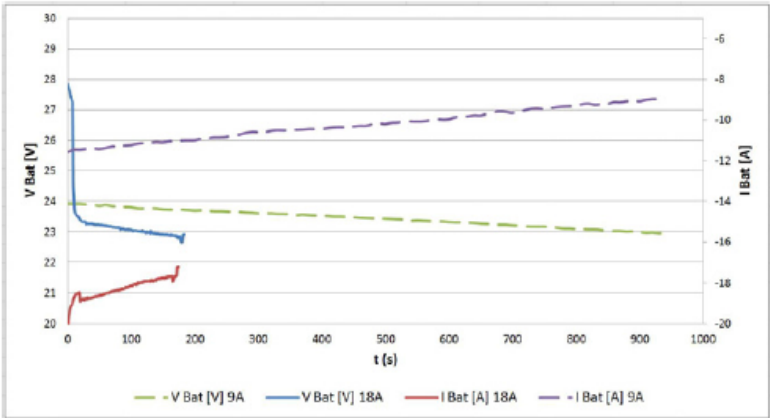
- Control of fuel cell operation as related to battery voltage levels – e.g. start fuel cell when battery voltage equals 25% of charge
- Management & control of overall system efficiency
- Calculation of system losses & overall efficiency



Battery Charging & Discharging

Each battery has its own unique charge and discharge characteristics based on its chemistry, the load and the temperature used. The HEL allows for the control of these parameters while collecting the data over time.

Build-In and user-provided batteries can be analyzed and compared.

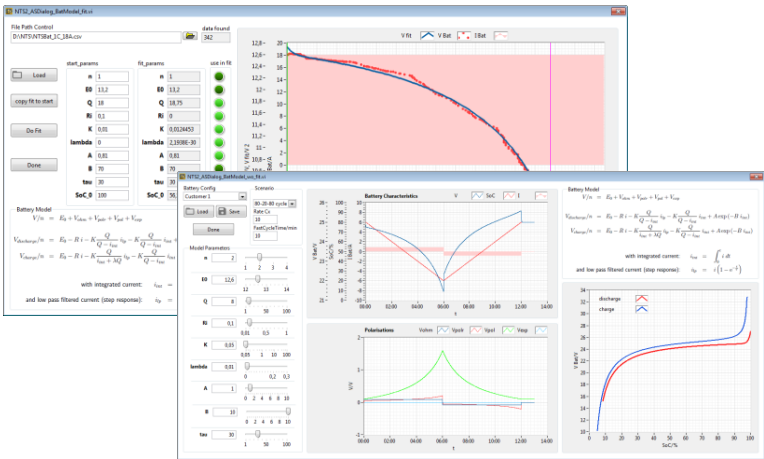


HEL: Battery discharge behavior displayed in relation to the current

Battery Models

The battery can be further analyzed by fitting a detailed battery model to the data. The obtained Parameters characterize the dynamic behaviour of the battery and give insight into the electrochemical processes.

This analysis task is seamlessly integrated into the Application Software.

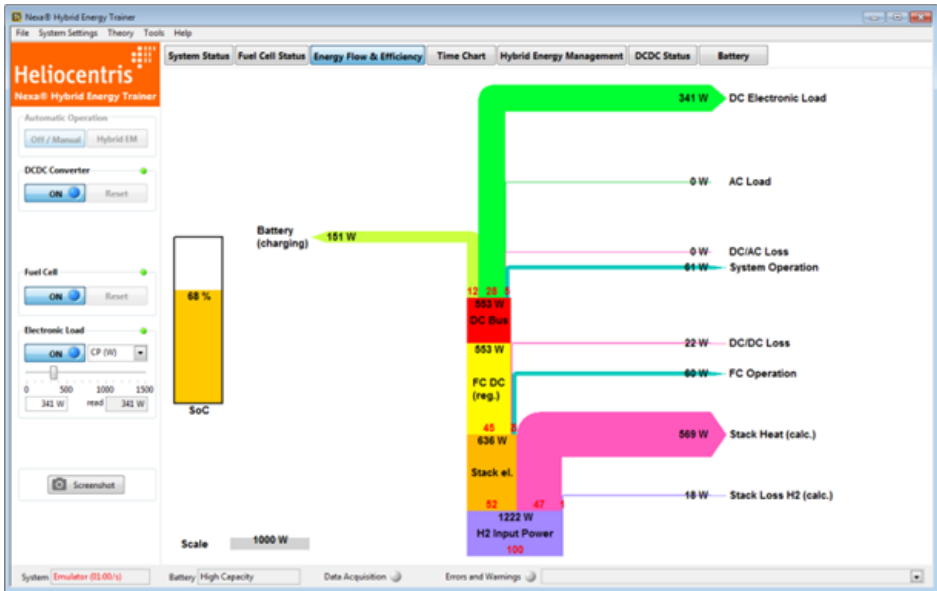


HEL: Parameters of a detailed battery model fitted to measured data

HEL Sankey Diagram

A clear visualization of system energy flow & efficiency.

Power (W) data automatically provided for each part of the system. Battery charging data and SoC data also displayed.



HEL: Sankey Diagram



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Contents

1	About This Document	4
1.1	Notices and Symbols	5
1.1.1	Symbols	5
1.1.2	Warnings	5
1.2	Accompanying Documents	6
2	Metal Hydride Canisters	7
	Absorption characteristic of metal hydride canisters	11
	H ₂ Absorption Experiment	11
	H ₂ Absorption Worksheet	13
	H ₂ Absorption Solutions	15
	Desorption characteristic of metal hydride canisters	19
	H ₂ Desorption Experiment	19
	H ₂ Desorption Worksheet	23
	H ₂ Desorption Solutions	25
3	Fuel Cell.....	27
	How to create a voltage-current characteristic curve	31
	FC V-I Characteristics Experiment	31
	FC V-I Characteristics Worksheet	33
	FC V-I Characteristics Solutions	35
	Creating a Power-Current Characteristic Curve	39
	FC P-I Characteristics Experiment.....	39
	FC P-I Characteristics Worksheet	41
	FC P-I Characteristics Solutions	43
	Creating a hydrogen-current characteristic curve.....	45
	H ₂ -I Characteristics Experiment	45
	H ₂ -I Characteristics Worksheet.....	47
	H ₂ -I Characteristics Solutions.....	49
4	DC/DC converter.....	51
	Creating DC/DC Characteristic Curves	53
	DC/DC Characteristics Experiment	53
	DC/DC Characteristics Worksheet	55
	DC/DC Characteristics Solutions	57

5	Battery Module.....	61
	Charge characteristics of lead batteries	65
	Charge Stages Experiment	65
	Charge Stages Worksheet	67
	Charge Stages Solutions	69
	Discharge characteristics.....	73
	Battery Discharge Experiment	73
	Battery Discharge Worksheet.....	77
	Battery Discharge Solutions	79
6	Energy Conversion and Efficiency	81
	Energy conversion and efficiency analysis	85
	Degree of Efficiency Experiment	85
	Degree of Efficiency Worksheet.....	89
	Degree of Efficiency Solutions.....	91
	Characteristics of energy conversion stages	95
	Energy Conversion Stages Experiment	95
	Energy Conversion Stages Worksheet.....	97
	Energy Conversion Stages Solutions	99
7	Hybridization	103
	Combination of Battery and Fuel Cell to Create a Hybrid System	105
	Hybrid Experiment	105
	Hybrid Worksheet.....	107
	Hybrid Solutions	109
8	Autonomous power supply	111
	Autonomous power supply	113
	Off-Grid Experiment.....	113
	Off-Grid Worksheet.....	115
	Off-Grid Solutions.....	117
9	Uninterruptible Power Supply (UPS).....	119
	Uninterruptible Power Supply.....	121
	UPS Experiment.....	121
	UPS Worksheet	123
	UPS Solutions	125