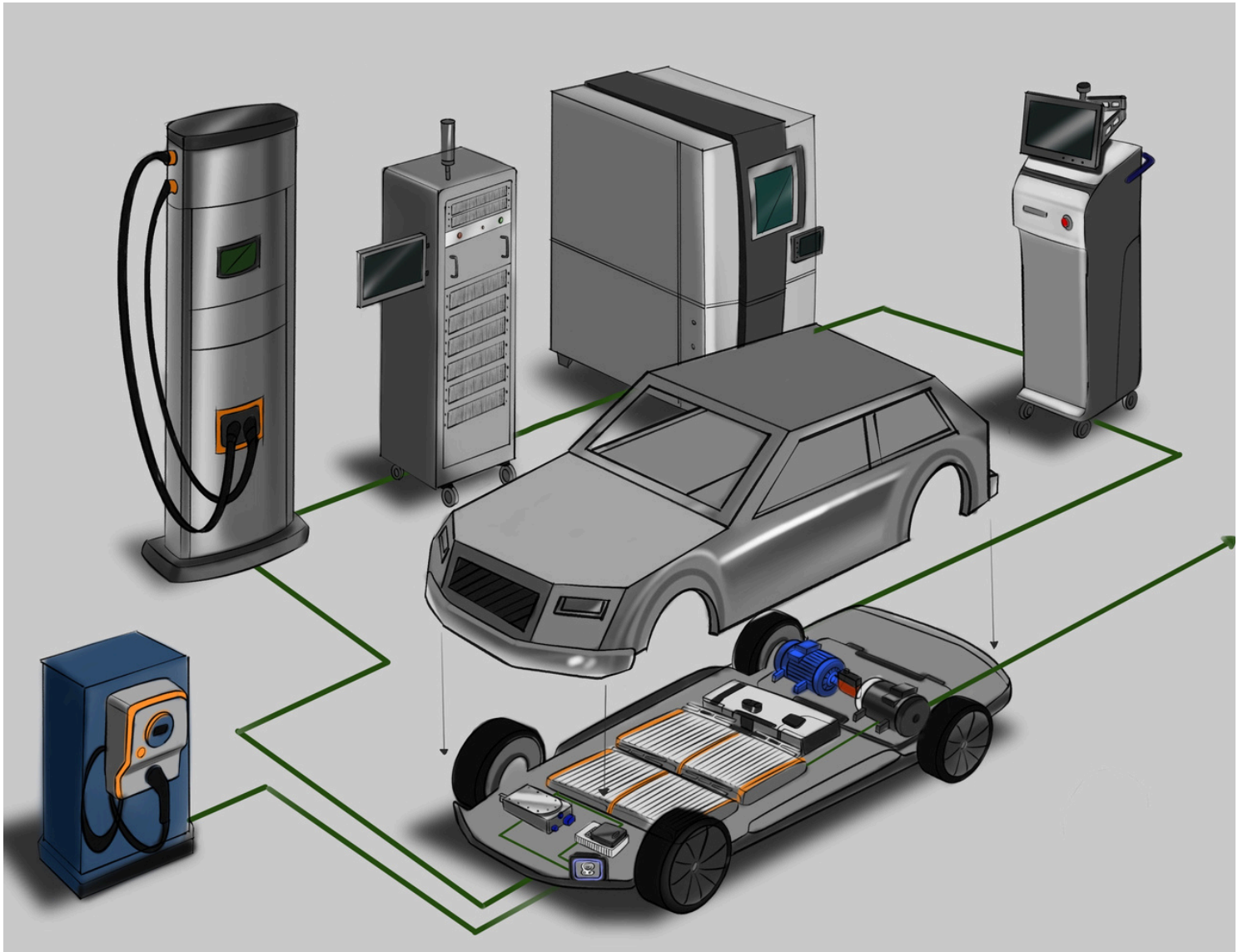
Electric Vehicle Lab



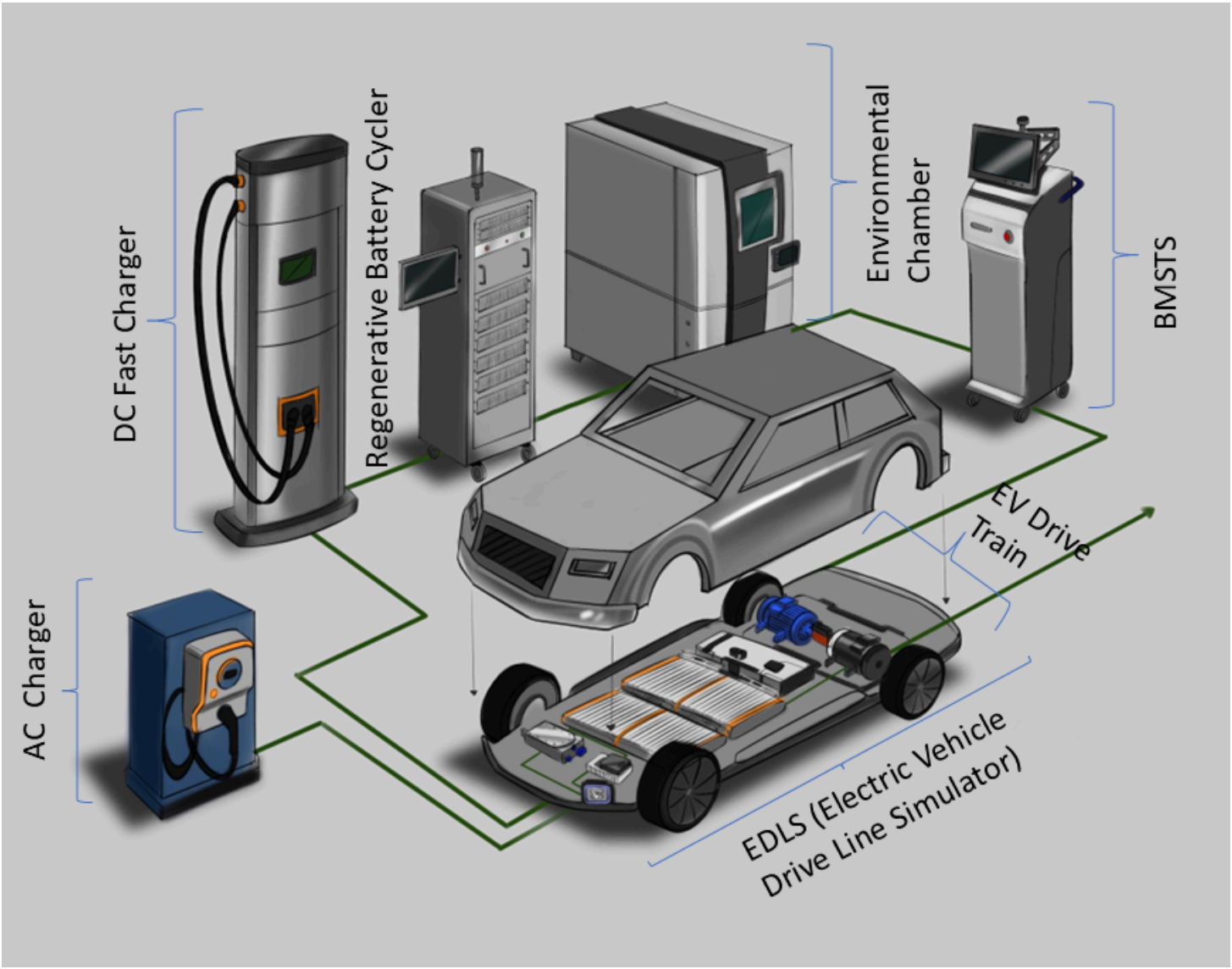
Electric Vehicle Lab

Electric Vehicle Lab is a comprehensive learning platform designed to provide users with theoretical knowledge, practical experience through structured experiments, and a foundation to initiate research in the field of electric vehicles.

Electric Vehicle Lab focuses on three core EV technologies: Battery Technology, EV Drive Train Technology, and EV Charging Technology, with products categorized accordingly.

Electric Vehicle Lab (EV-100)

- Battery Cycler with Data Analytics (EV-101)
- BMS Training System (EV-102)
- EV Drive Line Simulator (EV-103)
- Modular & Adaptive EVSE (EV-104)



Battery Cycler with Data Analytics

The Battery Cycler with Data Analytics (BatCycler) is a cutting-edge system designed for in-depth study and experimentation on EV traction battery systems. It features a battery cycler that conducts continuous charge and discharge cycles to evaluate battery performance. Additionally, it includes an Environmental Chamber, enabling the analysis of battery behavior under diverse environmental conditions.

Components

- Environmental Chamber with Temperature and Humidity Control
- Battery Cycler
- Resistive Load
- Input Power Analyzer (AC) with RS-485 communication
- Output Power Analyzer (DC) with RS-485 communication
- Lithium-ion Battery with RS-485
- Sensor Board
- Pull-up Boards
- Cooling Fans
- FPGA Controller
- Application Software

BMS Training System

BMS Training and Research System provides a cutting-edge platform for in-depth study and experimentation on Battery Management Systems (BMS) in battery packs. The BMS performs essential functions such as regulating charging and discharging, safeguarding the battery, ensuring cell balancing, and managing thermal conditions.

Components

- Resistive Load
- Input Power Analyzer (AC) with RS-485 communication
- Output Power Analyzer (DC) with RS-485 communication
- Customized battery pack without BMS for attaching to trainer unit
- Cooling Fans
- Sensor Board with Voltage and Current Sensor
- Pull up Boards
- FPGA Controller
- Application Software

Electric Vehicle Drive Line Simulator

The Electric vehicle (EV) drivetrain is a crucial system that converts electrical energy from the battery into mechanical power, propelling the vehicle forward while optimizing performance, range, and efficiency.

The EV Drive Line Simulator (EVDriveSim) provides students a single platform to study, experiment, and research EV drivetrains, with the added benefit of user-modifiable code for customization and hands-on learning. The system runs Drive Cycle Simulations like IDC and NEDC to simulate EV behaviour under different conditions.

Components

- Traction Motor
- Traction Motor Controller
- Loading Motor (Dynamometer)
- Resistive Load for Loading Motor
- Traction Battery
- Auxiliary Battery
- Auxiliary Battery Charger
- On board Charger
- Headlights

Modular and Adaptive EVSE

A charging station is a vital part of the Electric Vehicle ecosystem. Modular and Adaptive EVSE offers a learning platform where users can explore
the three key stages of EV charging:
Start-up, Charging Cycle a) Charging characteristics using onboard charger b) Charging characteristics using off-board charger, Shut-down
Modular and Adaptive EVSE (ModCharge) platform provides an opportunity to study and experiment with each stage, gaining hands-on experience with the start-up cycle, charging characteristics, and shutdown procedures.

Components

- Slow AC Charger
- Fast AC Charger
- Slow AC Charging Gun
- Fast AC Charging Gun
- Protection Circuitry
- Open Source Application Software

1. Technical Specifications:

S.No.	Product Component/Characteristics	Specification/ Description
	Battery Cycler with Data Analytics	
1.1	**Battery Pack**	
	Battery Type	Lithium Iron Phosphate LiFePO4
	Capacity	24 Ah
	Nominal Voltage	48 V
	Life Cycle (at 80% of DOD)	>3000
	Continuous Charging Current	1C
	Continuous Dis-Charging Current	1C
	BMS	Smart BMS with communication
1.2	**Environmental Chamber**	
	Temperature Range	-10°C to +60°C.
	Humidity Range	Humidity Range - 60% - 90%
1.3	**Battery Cycler**	
	Type	Charge Discharge System
	Voltage Range	40- 60 V
	Power Rating	1500 Watt.
	For Charging Cycle	Dc-DC Converter -2kW
	For Discharging Cycle	R Load - 2 kW
	BMS Training and Research System	
1.4	**Modular BMS with Controller**	
	Allowable Cell Series	Upto 15 S
	Max. Allowable Capacity	24 Ah
	BMS	Modular BMS with Communication
1.5	**Battery Pack**	
	BYOB (Bring your own battery)	
	Max. Voltage Allowed	48 V
	Max. Capacity Allowed	24 Ah
1.6	**Sensor Board**	
	Voltage and Current Sensor	LEM LV20P, LEM LA55P
	Electric Vehicle Drive Line Simulator	
1.7	**Traction Battery**	
	Type	Lithium Iron Phosphate LiFePO4
	Capacity	100 Ah
	Nominal Voltage	72 V
	Life Cycle (at 80% of DOD)	>3000
1.8	**Traction Motor**	
	Type	Three Phase PMSM

	Rated Voltage Rated Power Rated Speed Efficiency	72 V AC 6 kW 3000 RPM >90%
1.9	**Motor Controller** Rating Maximum Current Rated Output Voltage	 6 kW 125 Amp. 72 V AC
1.10	**Electric Dynamometer (Loading Motor)** Type Rated Power Rated Speed	 PMDC 5 kW 3000 RPM
1.11	**R Load for Loading Motor** Rating Voltage Maximum Current	 6 kW 72 V 84 Amp.
	Modular and Adaptive EVSE	
1.12	**AC Slow Charger** Charger Type Power Rating	 AC Slow Charger Level 1 1 kW
1.13	**DC Fast Charger** Charger Type Power Rating	 Level 1 DC Charger 10 kW
	CONSOLE	
1.14	**Central Controller** Type Communication	 FPGA RS-485

2. List of Experiments:

A. Battery Cycler with Data Analytics

1. Evaluation of charging characteristics of battery using CC. CV and CP mode.

2. Evaluation of discharging characteristics of battery.

3. Evaluation of charging/discharging of battery while charging/discharging with different C-rate.

4. Evaluation of Battery Charging/Discharging characteristics at different ambient temperatures. (Using thermal chamber)

5. Fuel economy comparison with new set of batteries and aged batteries.

6. Demonstrate the effect on state of health after a no. Of charge/discharge cycle.

7. Comparing performance of battery and finding gas gauge after charging battery

a) 0%-100%

b) 30%-100%

c) 50%-100%

8. A) Evaluate specific power, specific energy, life span, performance, and cost parameter of EV battery.

B) Evaluate SoH of EV battery after a no. of charge/discharge cycles.

B. BMS Training and Research System

1.Evaluation of SoC Estimation Techniques

a) Coulomb Counting Method

b) Modified Coulomb Counting Method

c) Voltage based Soc

d) Kalman Filter Method

2. Test battery bank at different temperatures and evaluate BMS cut-off points.

3. Test battery bank and perform the following tests:

overvoltage, undervoltage, overcurrent, short circuits, overcharging, and over discharging.

4. BMS Functional Testing and its integration with EV battery: Validate the basic functionalities of the Normal & Smart BMS, including voltage and current monitoring and how to perform its connection with EV Battery and other auxiliary systems.

C. EV Drive Line Simulator

1. Develop and Test different control algorithms on Power Electronics Converter/Inverter Design

2. Active/ Reactive/ Apparent power analysis of Central Inverter:

a) at different loading conditions

b) during Drive cycle simulation

3. Study speed-torque characteristics of DUT.

4. Study dynamic performance test data:

a) speed and torque spectrum

b) speed and torque oscillations

5. Study speed - controlled characteristic curve testing

a) Motor Voltage time curve

b) Motor current time curve

c) Time curves for speed and torque

d) Torque characteristics curve over RPM

e) Current characteristics curve over RPM

g) Characteristic curve of efficiency over RPM

6. Study Motoring MAP test (for mapping efficiency of traction motor)

7. Study Generating MAP test (for mapping efficiency of dynamometer)

8. Study efficiency parameter fluctuations while running traction motor

a) Motoring and electric-generating duty cycle tests

b) Motor overspeed test

c) Temperature rise test

d) Voltage fluctuation test

e) Controller overload capability test and controller protection function test

9. Study Drive cycle simulations using different drive cycles:

1) Indian Drive Cycle (IDC)

2) NEDC

10. Run drive cycle simulations with regenerative braking and compare battery depletion when drive cycle simulations run without regenerative braking.

11. To operate an EV in all four quadrants (forward motoring, forward braking, reverse motoring, and reverse braking)

D. Modular and Adaptive EVSE

1. Charging characteristics using on-board charger

2. Charging characteristics using off-board charger

3. CAN Data Analysis: Analyze and interpret CAN bus data from the BMS for insights into system performance. Data Logging and Monitoring: Record and analyze real-time data from the battery system during operation.

4.Communication Protocol Testing (CAN Bus): Verify data communication between the BMS and external systems using CAN protocol.

3. Technical Advantages:

- Modular and Scalable Design
- System can in installed in a regular classroom environment.
- System comes with an integrated test subject and user do not need to buy an extra Electric Vehicle for testing and research.
- Open-source software platform enables user to redevelop algorithms and test cases.

4. Technical Characteristics:

- Study characteristics of EV Motor, EV Battery, EV Charger, EV drive train and other EV accessories such as lights, etc. in an integrated environment.
- Open-source software to redevelop own algorithms and test cases. Complete testing of EV ecosystem possible with different drive cycles & algorithms.
- Detailed study of every component in an EV ecosystem possible.
- Study of EV ecosystem in different environmental conditions.
- System comes with on-board as well as off board charger to study the difference in characteristics and communication.
- Complete ECU redevelopment possible.
- User can learn assembly/disassembly, individual component working and testing and individual component working and testing in an integrated environment.
- Everything is software controlled with special focus on safety.
- Control unit displays all the measured parameters which can be exported to PC in graphical form as well as dataset form.