

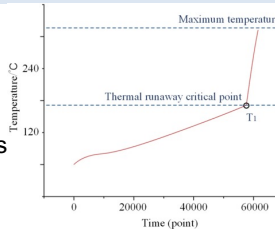
Analysis of Fire Safety Sensors and Controls with Design Scenarios for a Reliable Residential and Commercial V2G Integrated Energy Storage Systems

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INTRODUCTION

EV Battery malfunction
Cause **Thermal Runaway**
potential Fire danger impacts
Vehicle to Grid system.



METHOD

The research goals to design safe V2G System:

- Analyze Sensors and Controls to identify strengths of the EV Battery Management System
- Develop Fire Prevention Safety System Design
- Analyze Real Time Thermal Runaway Detection

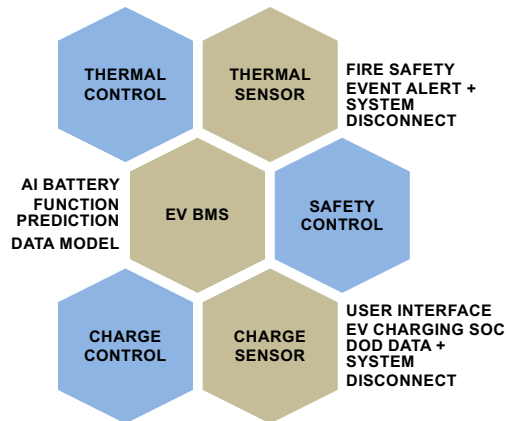


Figure shows AI Battery Fire Event Prediction Model

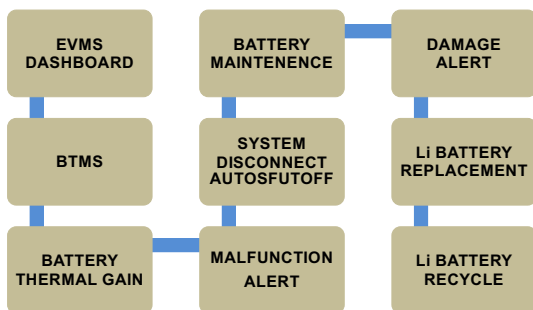
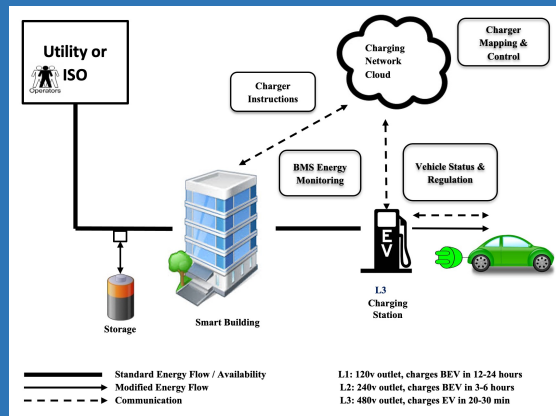


Figure shows Battery Management Safety Design Data Flow

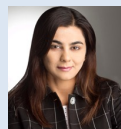
How to optimize V2G technologies, EV Battery Management System controls, sensors to integrate with Distributed Energy system to manage Fire safety and reliability concerns?

Ensuring fire safety in V2G systems approach involves advance sensors for early detection and Battery Thermal Management Systems for monitoring, control and fire suppression capabilities for mitigating risks and enabling safe operation of V2G technology.



Smart Energy Enterprise Development Zone V2G Design Scenario

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RESULTS

Table Compares merits and drawbacks of EV Battery Sensors and Controls approach.

COMPARATIVE ANALYSIS BATTERY SENSORS				
Sensor Type	Detection Range	False Alarm Rate	Power Consumption	Trade Offs
Voltage	Cell or Pack Level to System Level (V)	High with Aging/Degradation Low with Advance Algorithms	Low	Analog to Digital Converters, Critical for SOC, SOH
Current	Charging to Discharging Amps Range	Low for Direct Current	Moderate High Power Heat Dissipates	Crucial for SOC values Requires Thermal Management
Temperature Thermo Resistance Detector	Operation Range -80c to 150c	-40°C to +125°C	Low	Thermal Management preventing Thermal Runaway
Gas Pressure Metal Oxide, Infrared Electro chemical	High Sensitivity to Trace amounts, Accurate	Fluctuates, Low to target Gas	Moderate	Targets Volatile Organic Compound, Hydrocarbon

Fire Safety Risk Assessment Results Ref. IJARIT

EV BATTERY MANAGEMENT SYSTEM RISK ASSESSMENT	RESULT
Voltage Measurement Accuracy	±0.05V
Temperature Detection Response	3.2 Sec
Gas Detection Response Time	1.8 Sec
Suppression Activation Delay	2.3 Sec

Vehicle to Grid Readiness Survey Results:

V2G EV BMS SURVEY REVIEW			
Category	Key Findings	Acceptance	Status
EV User	EV Battery Safety Concern	High	EVs Deployed
V2G Policy	Battery Fire Safety Regulations and Standards	High	In Progress
V2G AI BMS	V2G AI Pilot Testing	High	Under Development

Make suggestions to make something better.

Many possible degradation models can be leveraged in VGI simulations, one example: Battery Degradation V2G Scenario Ref. LBNL
 $Q_{loss}^{total} = [a \cdot T^2 + b \cdot T + c] e^{(d \cdot T + e) \cdot h \cdot v \cdot A_{h,v}} + \int_0^t e^{-E_a/RT} \cdot i^2 dt$
 Capacity loss caused by cycling Capacity loss caused by calendar aging