PTSa Networking Event

:

Potential for local Manufacturing of Battery Pack components

Presented by:
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29th June 2023

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UNIVERSITY of the WESTERN CAPE

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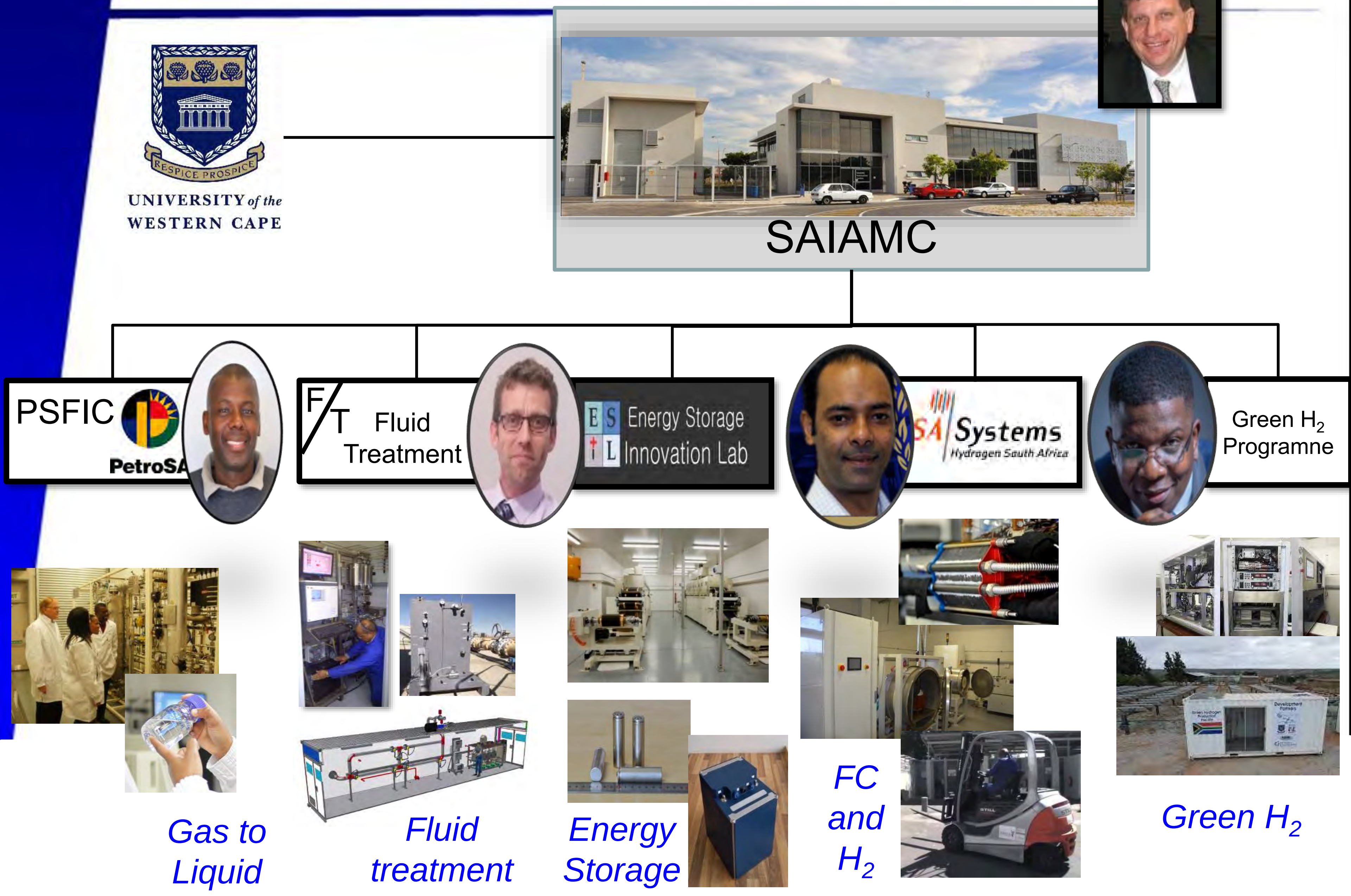
About the presenter

About the presenter

- Bachelor of Technology in Chemical Engineering Cape Peninsula University of Technology (CPUT) 2017-2019, **SA**
- Energy Storage Systems Course Stellenbosch University in September 2018, **SA**
- Affiliate Research Student at University of the Western Cape from 2018 till now, **SA**
- Trainee at uYilo Electric Mobility Programme from May- August 2018, **SA**
- Master of Engineering in Chemical Engineering at CPUT from 2020-2023, **SA**
- Argonne National Laboratory Graduate from April 2022 to October 2022, **USA**
- Reviewer for Electrochemistry Communication from August 2022 till now
- Plant Manager at Energy Storage Innovation Lab/UWC from 2019 till now, SA

Introduction: Background of SAIAMC



Li-ION PROGRAMME: Infrastructure at UWC

Infrastructure:

- ***Ink mixers***
- ***Ink casting lines***
- ***Electrode cutters***

- ***Electrode Calendaring***
- ***Electrode slitter***
- ***Electrode/ winding***
- ***Slotting machine***
- ***18650 Sealer***

- ***Stacking machine***
- ***Dry room (+ de-humidifiers)***
- ***Electrolyte filling carousel***

- ***Vacuum sealer***
- ***Tab and pack welding***
- ***Cell packaging***

- ***X-ray inspection***
- ***Cell performance testing***
- ***Quality control equipment***

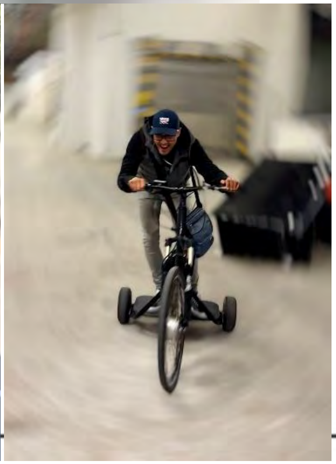
Achievements: UWC-Lumieres Technology

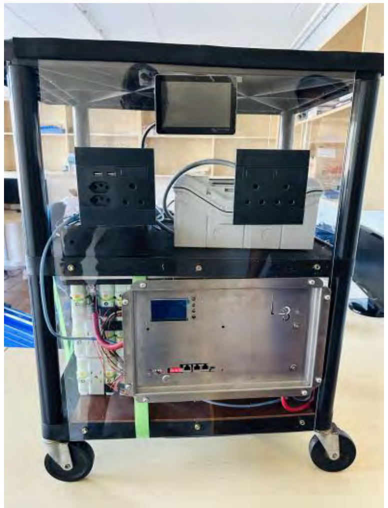
1Kw E-Bike

Solaris and Solar Tree

Achievements : UWC In-house development

1 Kw E-Trike





Mobile and Stationary UPS

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Achievements : UWC- Uyilo/NMU collaboration

NELSON MANDELA
UNIVERSITY

UYILO
E - MOBILITY PROGRAMME

LIBPACK: UWC commercialization partner

LIB PACK (PTY) LTD

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Infrastructure:

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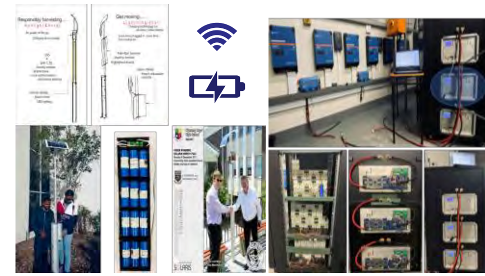
"Unique Centre of LIB Production on the African continent."

Unlocking commercializatio n

1

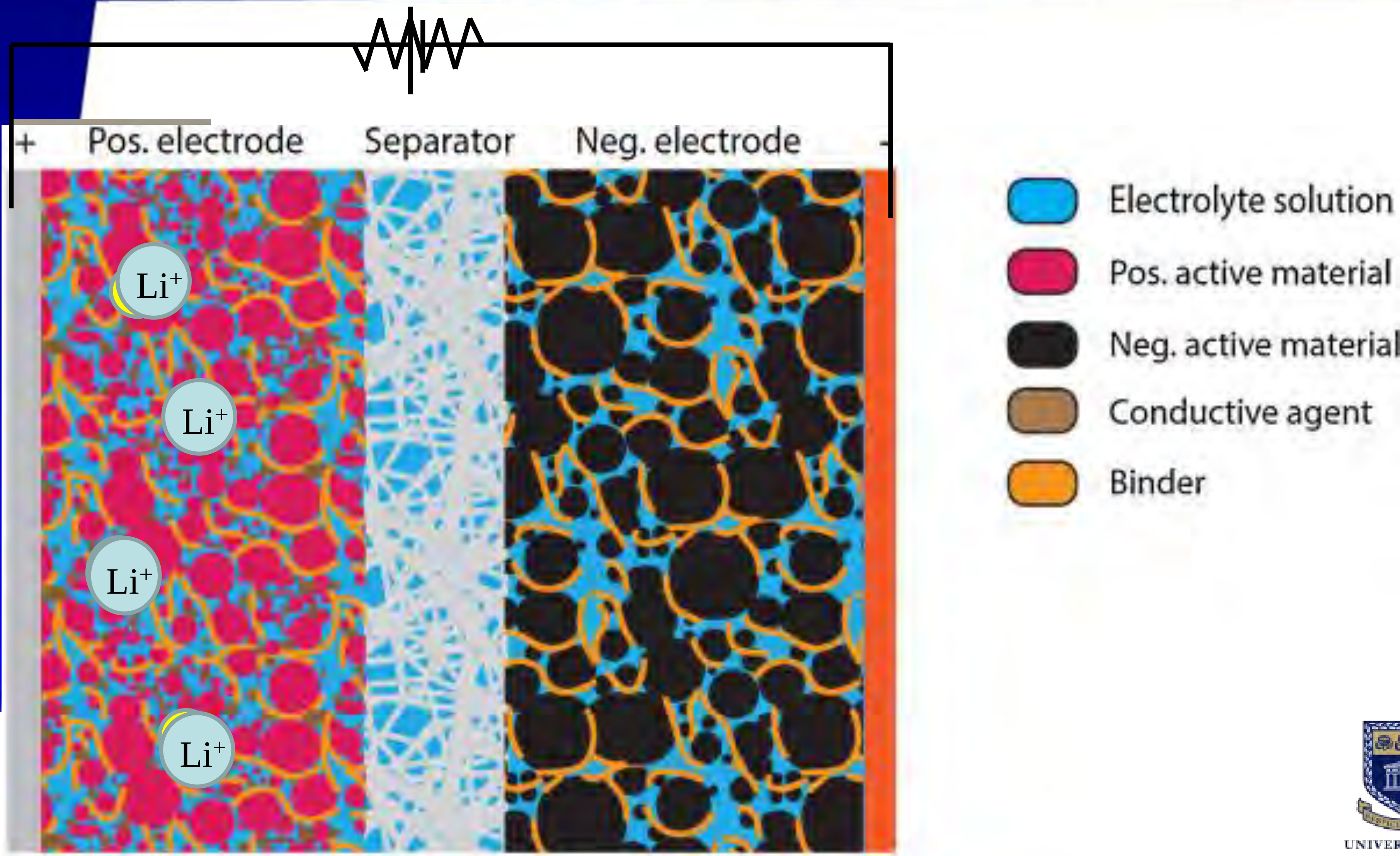


2

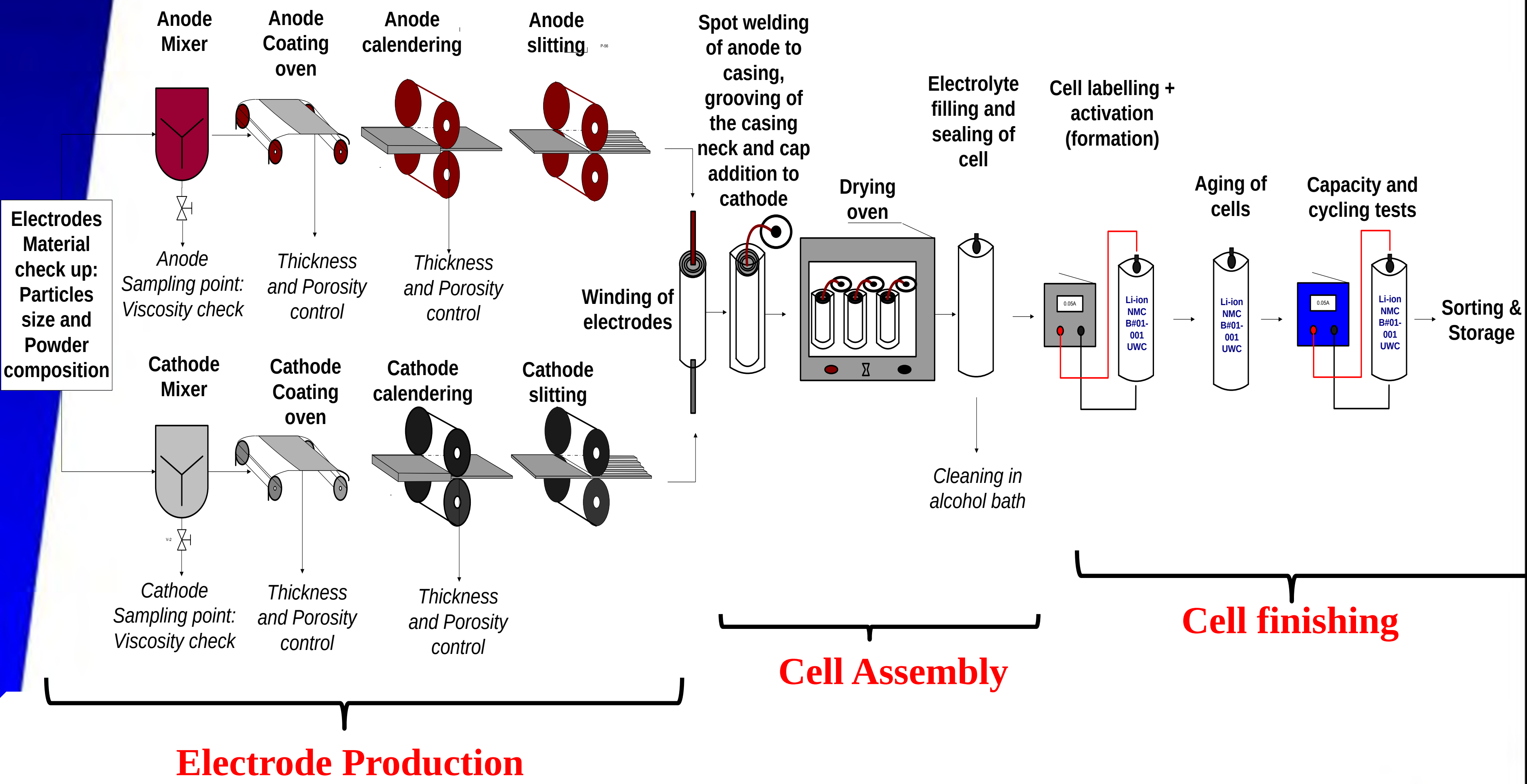
3

1. SOLARIS	2. ARBRE SOLAIRE	3. TRICYCLE ELECTRIQUE

The Basics of Lithium Ion Battery: Working Principle

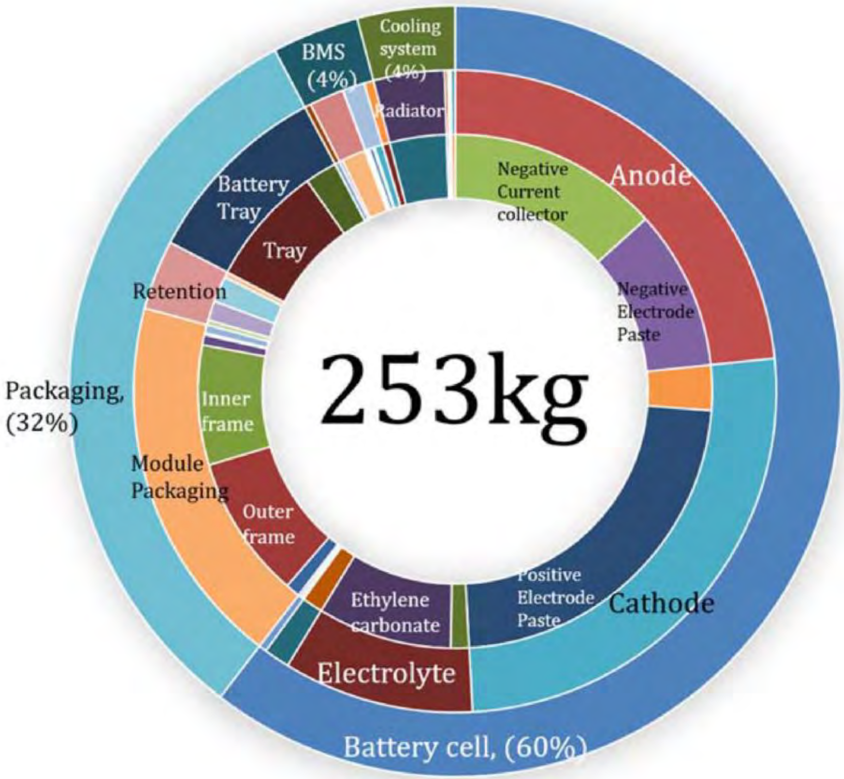


The Basics of Lithium Ion Battery: Assembly overview



Pack components: Weight breakdown

Weight breakdown of packs



Components breakdown

Pack components: Cost breakdown

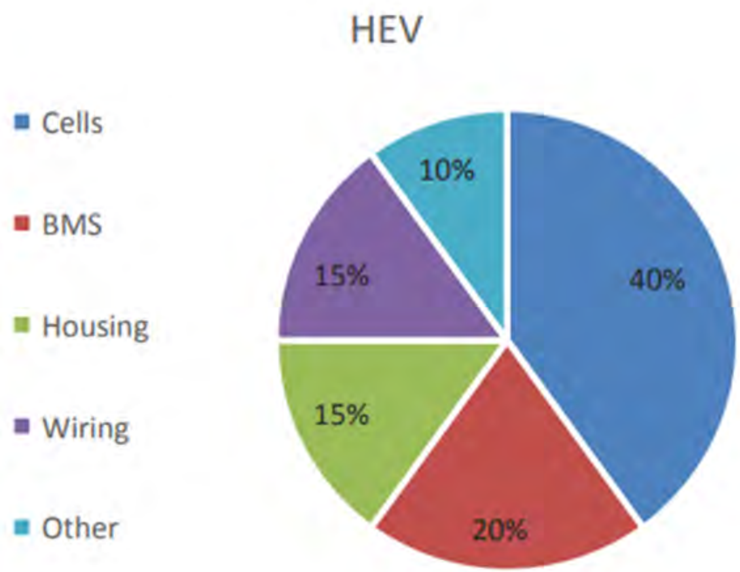


Figure 3
HEV battery cost breakdown. HEV, hybrid electrical vehicle.

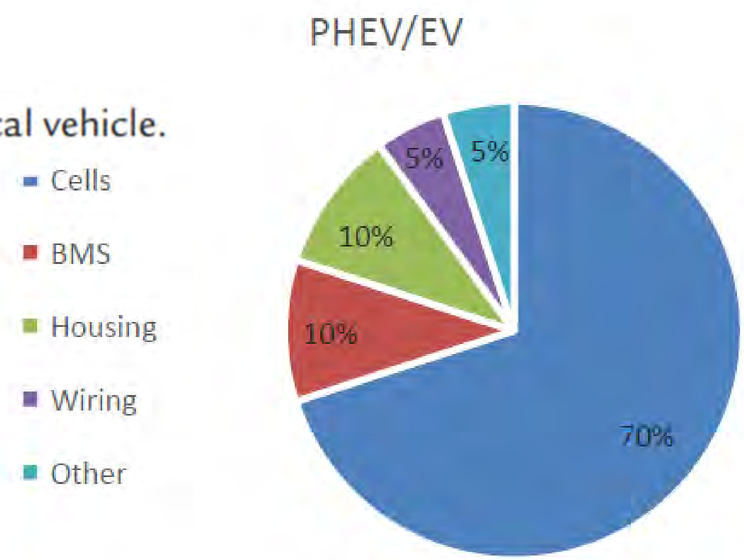
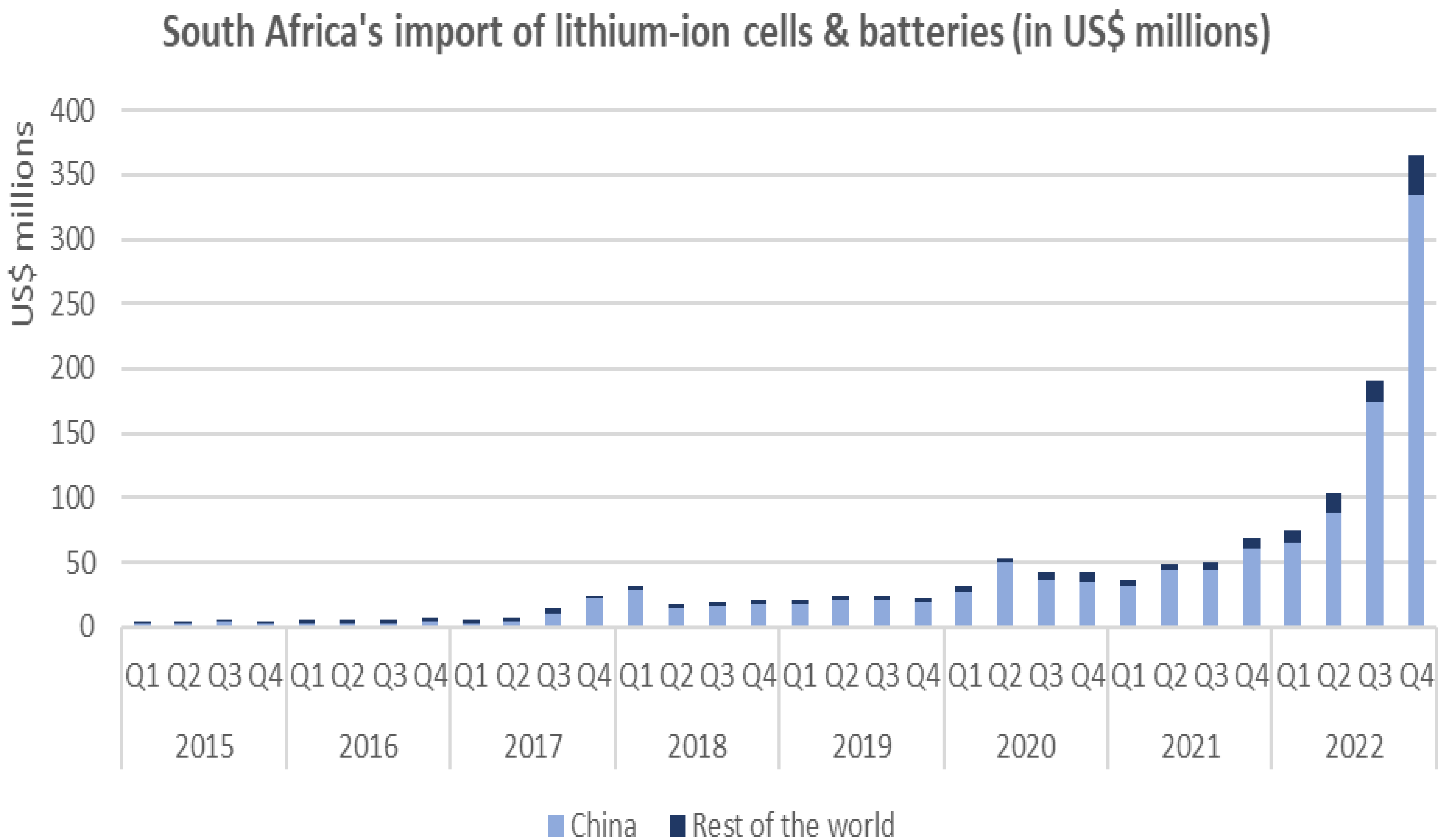


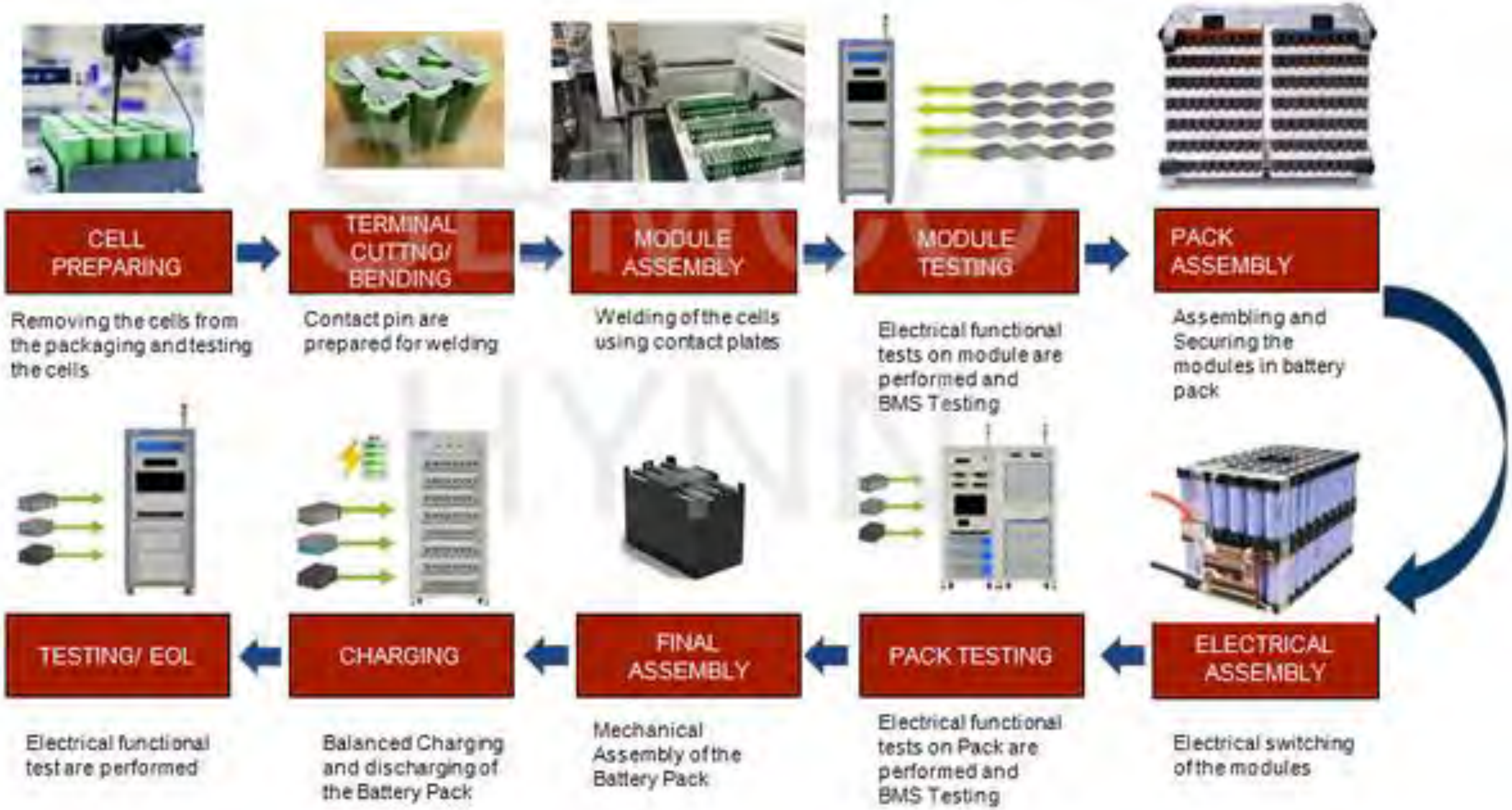
Figure 2
PHEV/EV battery cost breakdown. BMS, battery management system

SA Lithium-Ion Battery market



Source: Montmasson-Clair, based on TradeMap data

Pack Assembly: Overview



Pack Assembly: Load profiling

- The load profile approximates the aggregate energy required from a power system over a particular time period (e.g., years, days, hours).

- Approximating the energy demand is very crucial for sizing the energy storage devices such as batteries because the capacity of such devices depends on the total energy required by the connected loads.

- This computation is also of value for energy performance applications, where it is significant to estimate the energy usage in a system.

https://electricalacademia.com/electric-power/load-profile-calculation-solved-example/

Pack Assembly: Software based load profiling

Electric Load

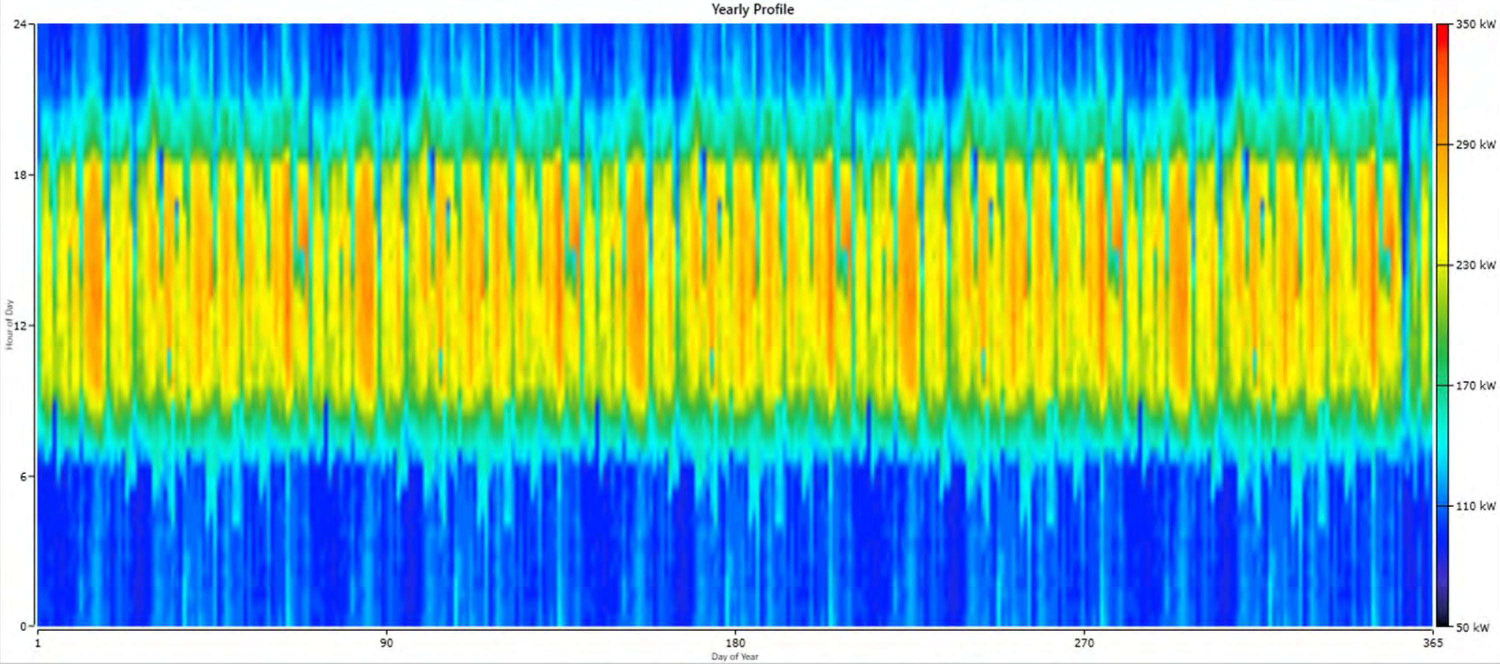
Name: Primary Load

Year to model: 2020

January Profile:

Hour	Load (kW)
0	109.33
1	107.98
2	107.37
3	107.37
4	106.63
5	109.06
6	121.37
7	156.98
8	189.14
9	227.97
10	240.35
11	242.55
12	245.95
13	246.33
14	239.23
15	236.9
16	224.33
17	211.71
18	190.63
19	157
20	142.23
21	121.38
22	113.82
23	109.4

Show All Months...



Time step size: 30 minutes Peak month: July Crest factor: 1,77

Random Variability:

Day-to-day (%): **10.397** Timestep (%): **10.436**

Load Metrics:

Metric	Baseline	Scaled
Average (kWh/day)	4,196.6	4,196.6
Average(kW)	174.86	174.86
Peak (kW)	329.07	329.07
Load factor	.53	.53

Scaled Annual Average (kWh/day): 4 196,68

Plot Export

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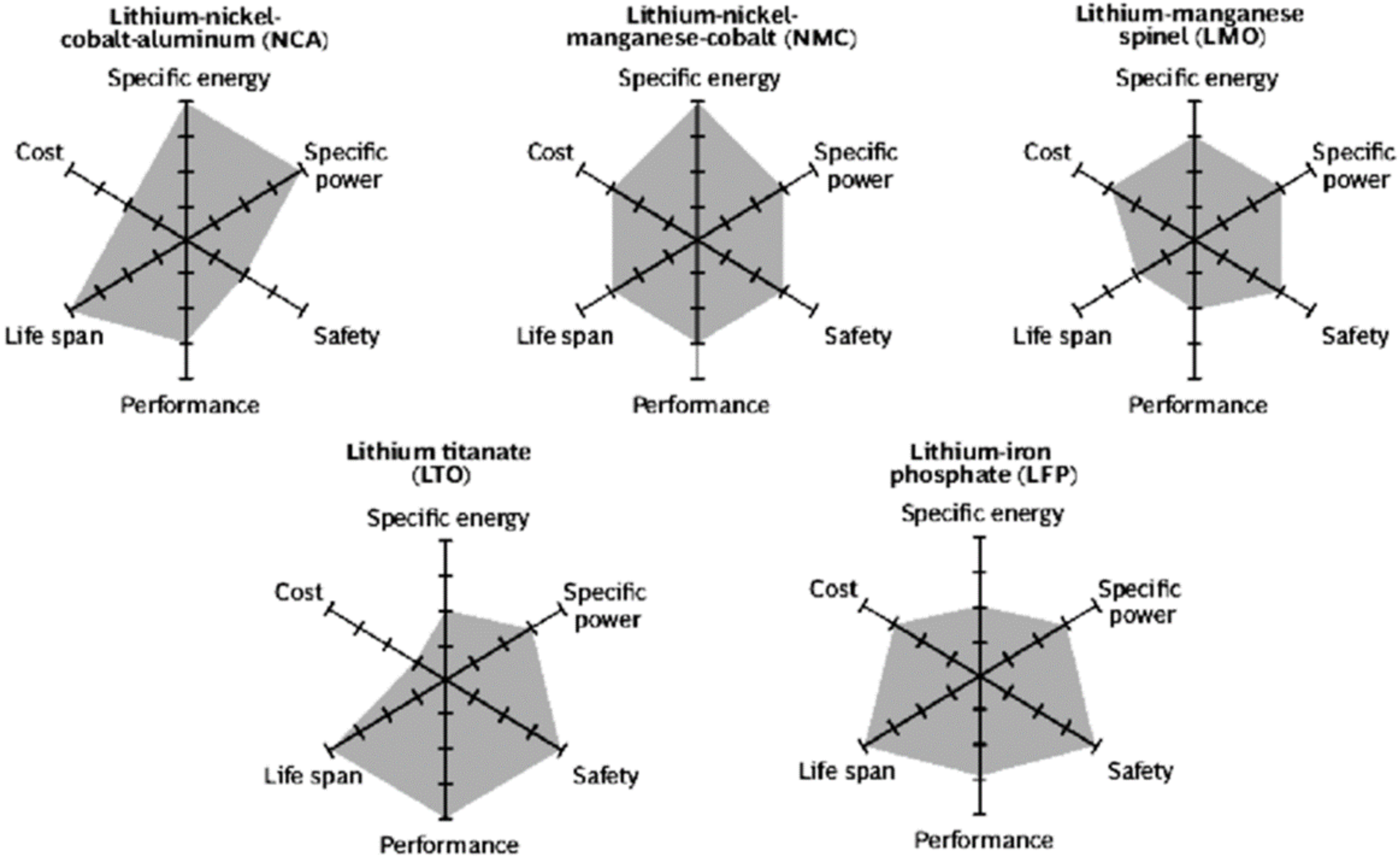
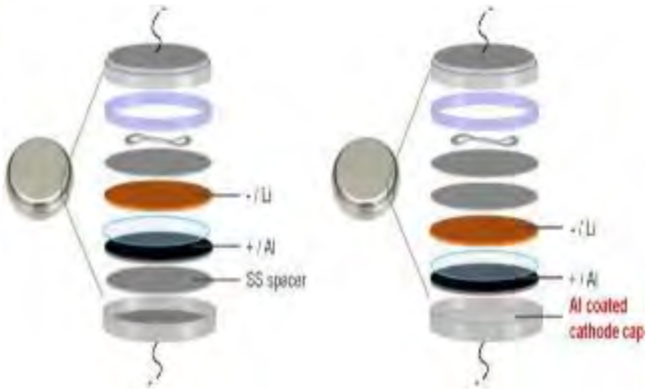
Pack Assembly: Criteria for cell chemistry selection

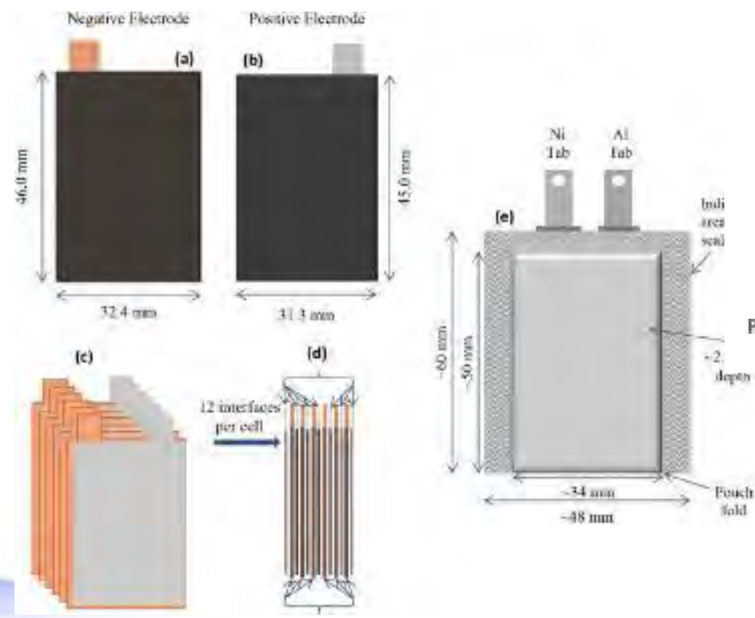


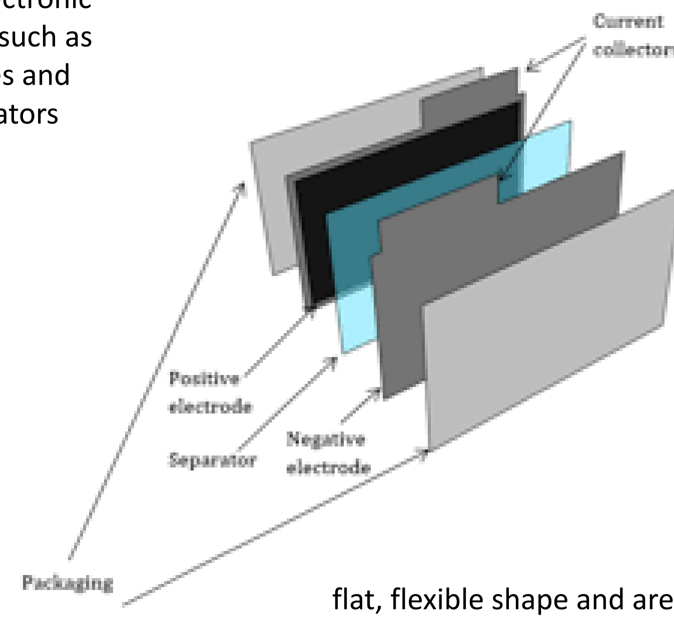
https://batteryuniversity.com/article/bu-205-types-of-lithium-ion

Pack Assembly: Cell geometry selection



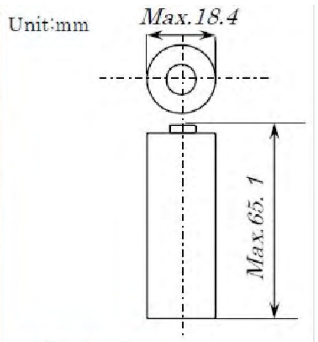
small electronic devices, such as watches and calculators



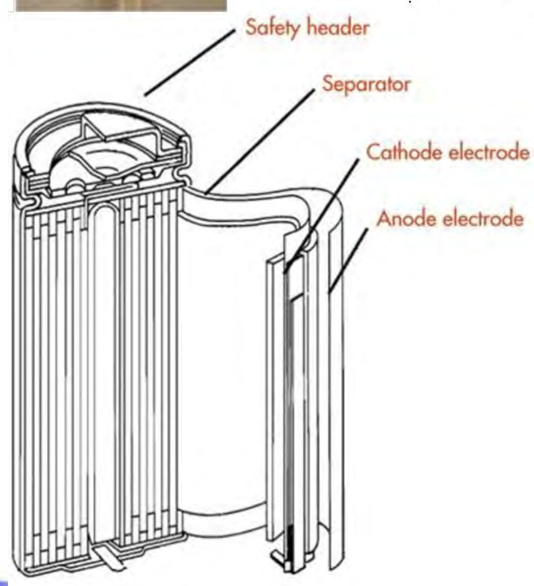


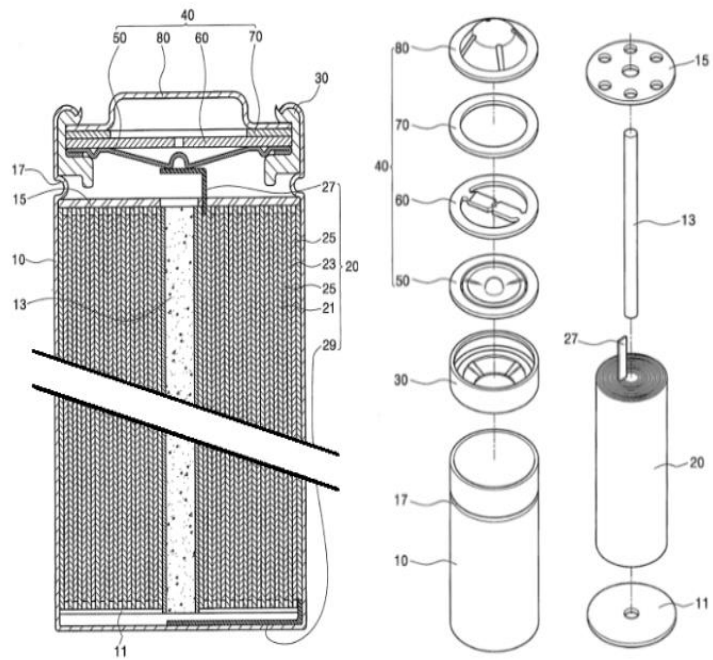
flat, flexible shape and are often used in applications that require a thin, lightweight design, such as wearable devices and drones. made by laminating layers of electrodes and separators, and then sealing them in a flexible pouch.

Cell geometry selection

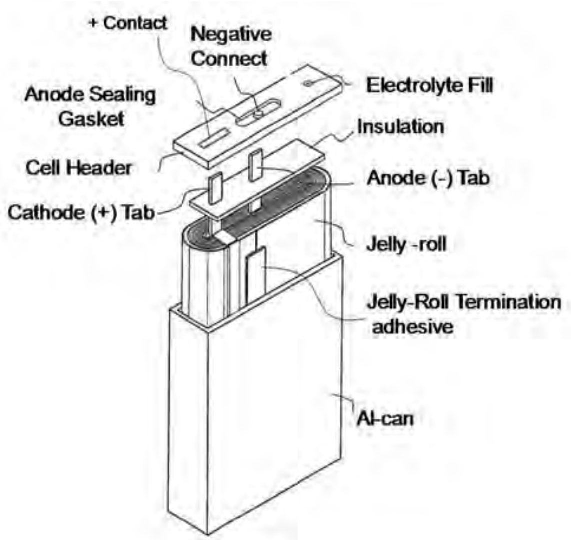


high-power applications, such as power tools, electric vehicles, and grid energy storage systems. They are available in different sizes and capacities, with the most common sizes being 18650 26650, 26800, 32600 and 46800

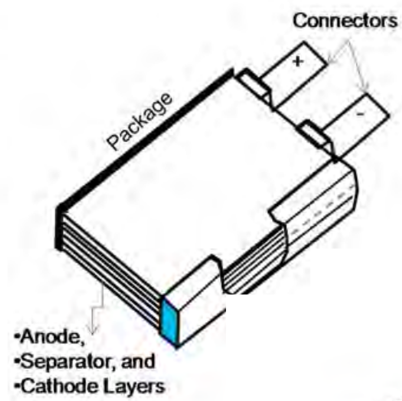




Pack Assembly: Cell geometry selection

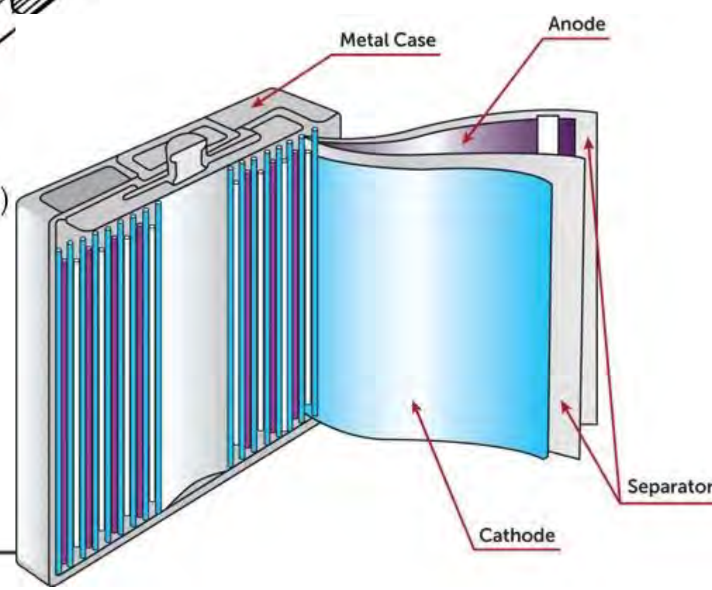


(a)



(b)

rectangular or square shape and are often used in consumer electronics, such as smartphones and laptops. They are typically thin and flat, making them ideal for applications that require a compact design



Calculating Battery Pack Voltage Range

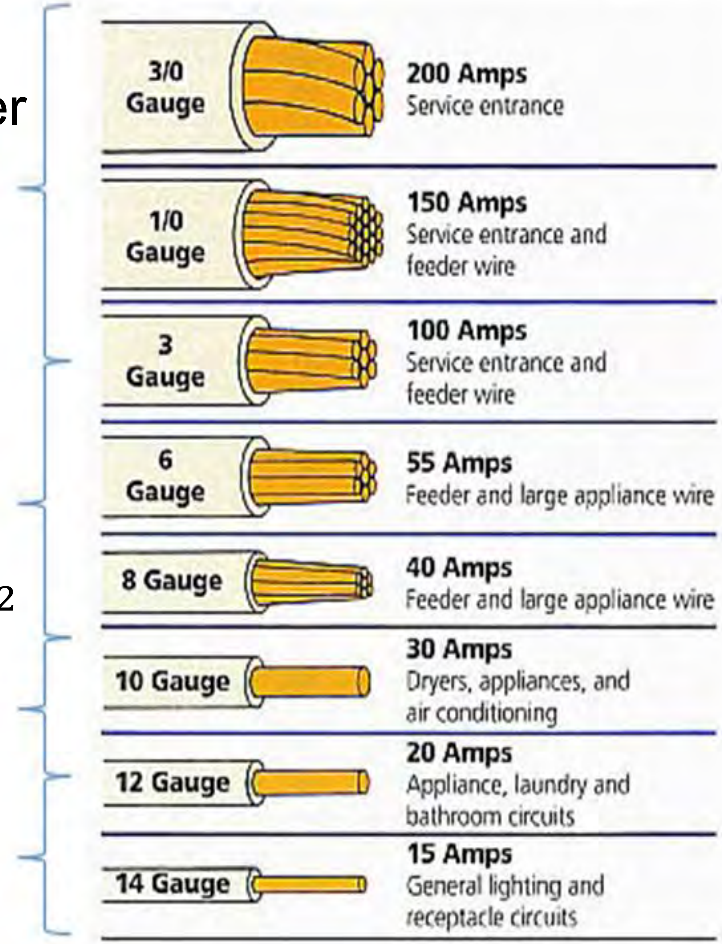
- **Assuming the cells operating voltage range is 4.2-3V the battery pack voltage range will be:**

Maximum voltage = 108*4.2 = 453.6V

Minimum voltage = 108*3 = 324V

Pack Assembly: Sizing of electrical

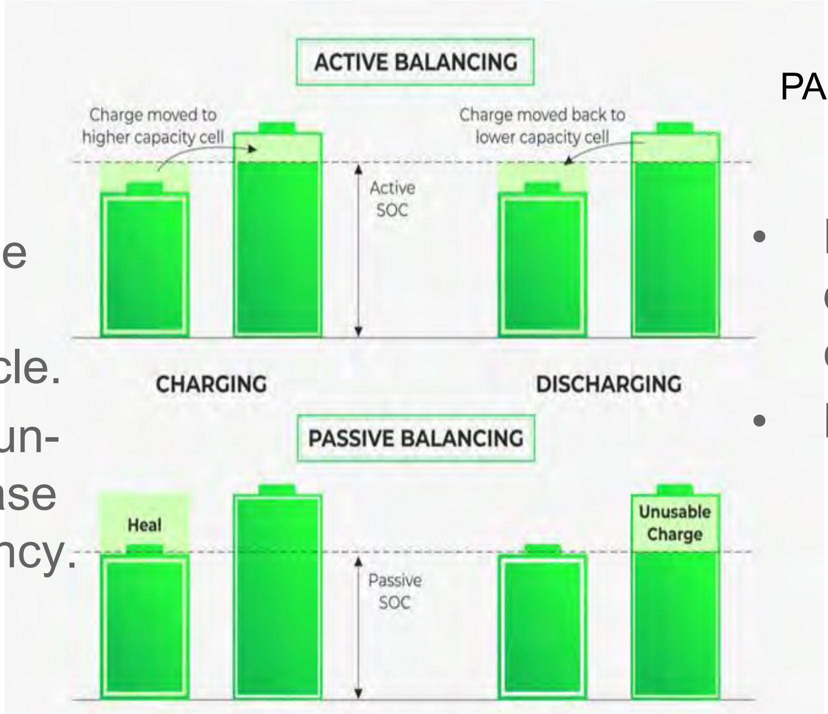
- Cable sizing
- Proper installation is primarily a matter of sizing a cable to match its task, using the correct tools to attach terminals, and providing adequate over-current protection with circuit breakers.
- $\frac{current}{3} = cable\ size\ in\ mm^2$
- In our case **24 AWG, area 0.205** mm^2 max current 0.577A
- Bleeding current= $\frac{\text{Voltage of cell}}{\text{Bleeding resistor}}$



Pack Assembly: BMS selection

ACTIVE BALANCING

- Redistributes charge during the charging and discharging cycle.
- Increases system run-time and can increase the charging efficiency.
- Energy transfer



Comparison of active and passive balancing

PASSIVE BALANCING

- Dissipates charge during the charge cycle.
- Burning of energy

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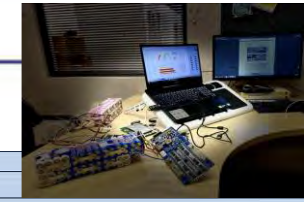
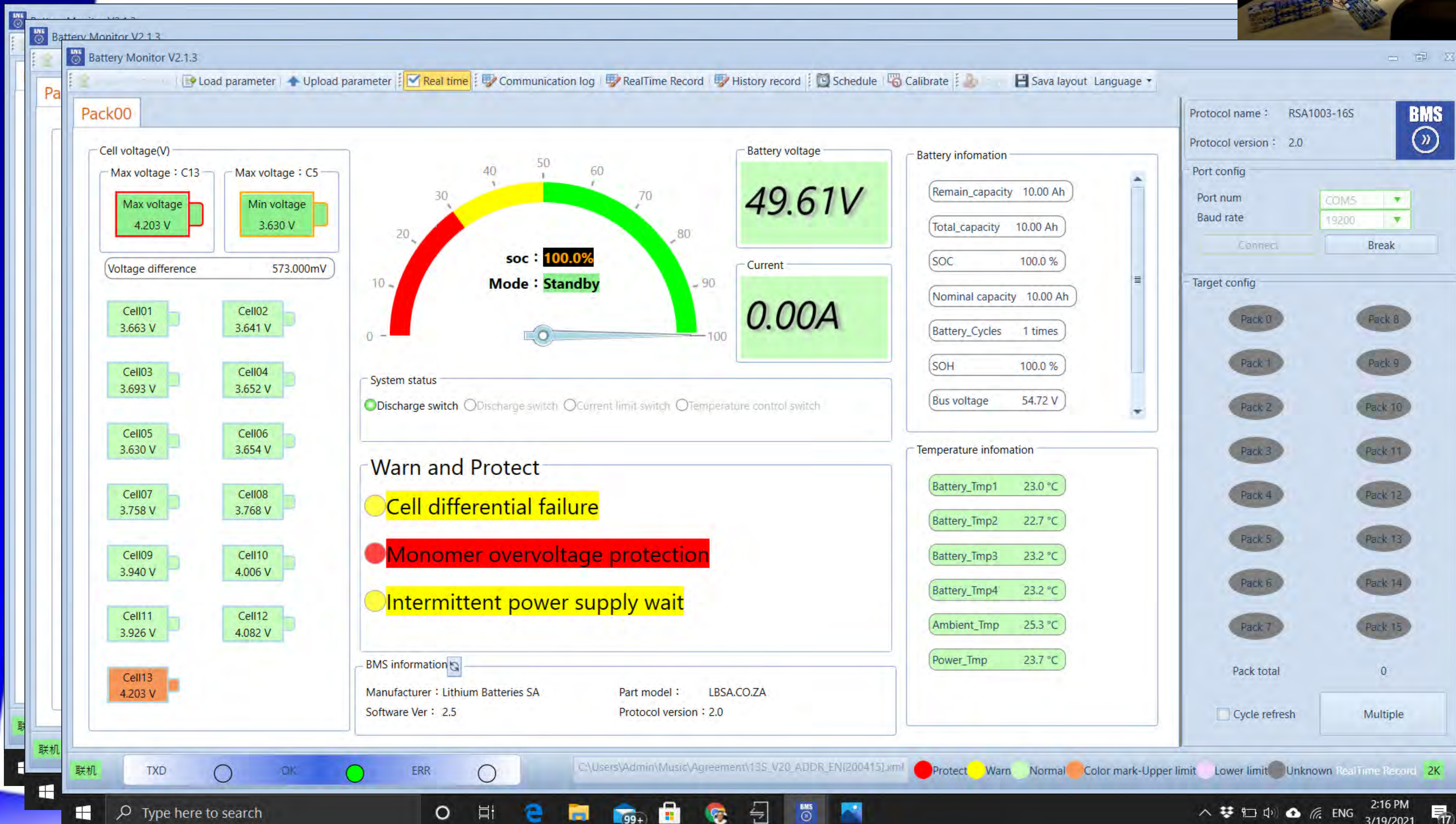
Pack Assembly: BMS configuration





Olivier Kasikala

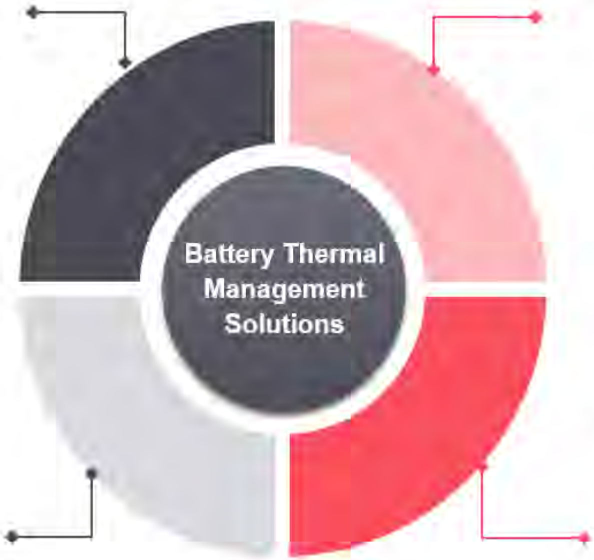
Pack Assembly: Thermal Management

Air Cooling

- Requires simple components
- Not effective solution as compared to liquid cooling available in the market
- Requires 2 to 3 times more energy to takeaway heat compared to others

Liquid Cooling – Indirect

- Coolant circulates through system of pipes, similar to cooling systems found in current IC engines
- Requires high heat capacity coolants with corrosion inhibitors
- Commercialized method across industries



Phase Change Material

- Effective in cooling function, but requires large volume space
- Phase change composite are being commercialized across material handling, energy storage, and transportation

Liquid Cooling – Direct

- Battery is submerged directly into the coolant.
- Requires coolant to be low to no conductivity to maintain vehicle safety
- Increasing R&D efforts across industries

Pack Assembly: Pack monitoring system

Cells

- Chemistry
- Burst Disk/CID
- Separator Materials
- PTC

Module

- Battery management system
- Enclosure design
- Thermal management

Pack

- Pack controller (master BMS)
- Redundant sensing
- Directional venting

Space

- Battery monitoring system
- Air temperature regulation

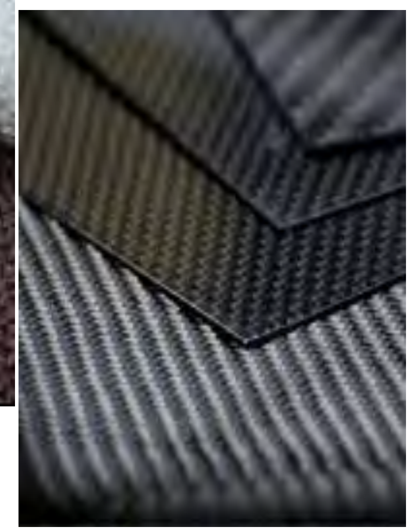
Pack Assembly: Pack housing solutions

STEEL

ALUMINUM

CFRP

GFRP

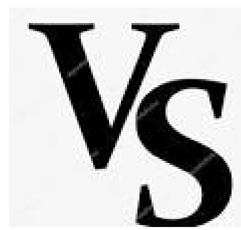


Carbon fiber reinforced polymer
Glass Fiber Reinforced Polymer

Pack Assembly: Pack housing solutions

Plastic enclosure

- Plastic enclosures protect smaller battery systems without structural demands.
- Hybrid and stop-/start-type automotive batteries use plastic enclosures for lithium-ion cell protection.
- Large battery packs utilize plastics in internal components for enhanced functionality.
- Composite covers, such as in the Chevrolet Volt, combine vinyl ester resin and glass fibers for added durability



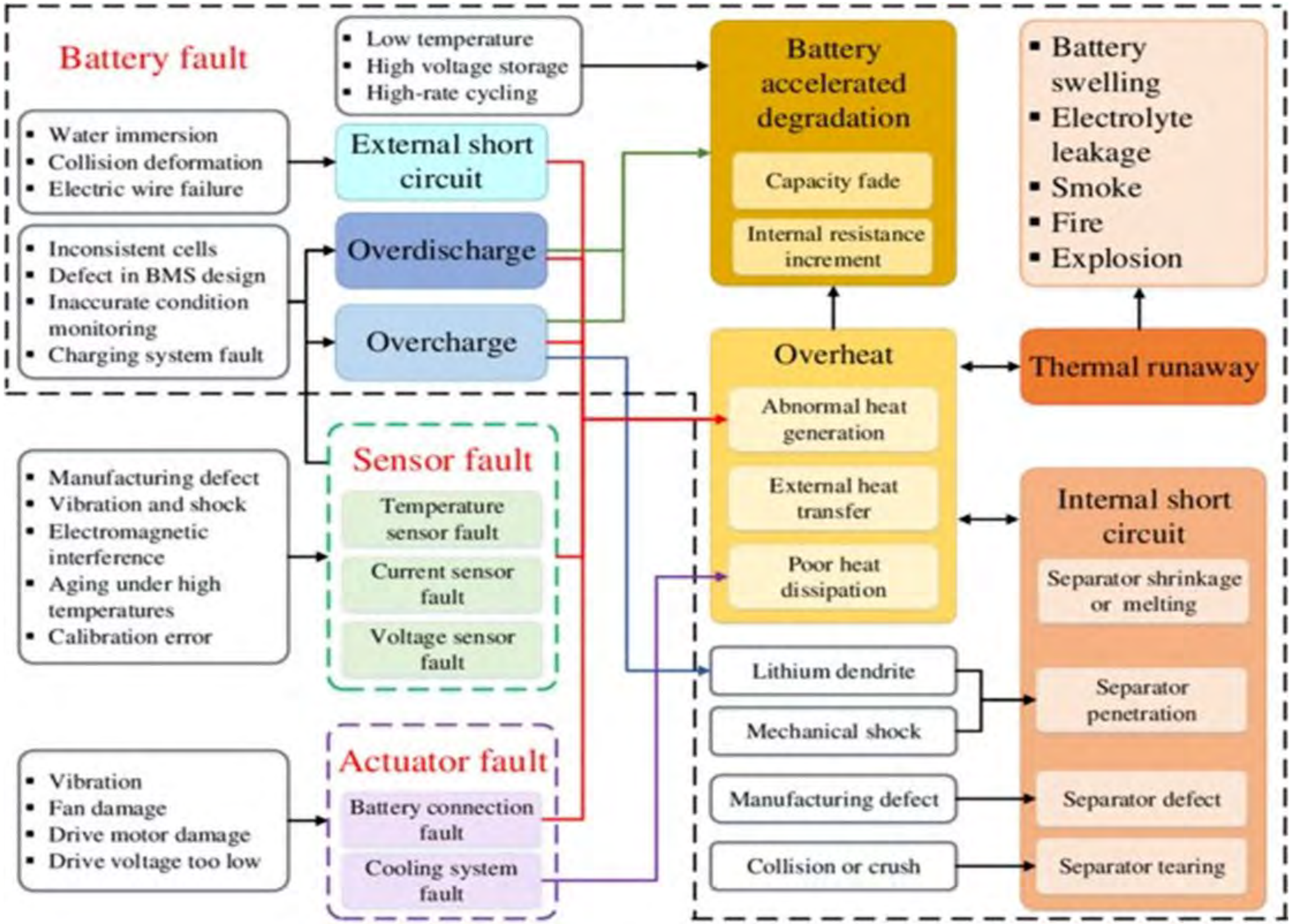
Steel enclosure

- Stamped steel enclosures: High strength and low cost, but additional attachments increase processing time and cost.
- Aluminum enclosures: Can be stamped or die-cast; stamped pieces may require additional thickness for strength. Die-cast aluminum offers high strength but can be expensive.
- Plaster casting: Cost-effective for tooling aluminum enclosures, but may result in porosity and weaker spots, suitable mainly for prototypes.
- High-pressure die-cast (HPDC) aluminum: Lightweight and allows integration of various features, making it ideal for lithium-ion battery solutions

Pack Assembly: Safe assembly practices

Process step	Critical factors and challenges	Production solution
Handling	Puncture or contamination of surface	Remove any contaminants especially metal
	Low contact pressure	Torque screwdriver to regulate pressure
	Tight fit and precise positioning	Powerful logistics systems
Contacting of BMS and sensor system	Sensors are very damageable, require precise handling	High-precision handling
	Danger of short circuit by inaccurate positioning of sensors and printed circuit board	High degree of automation desirable
Assembly of housing, insertion and fixation of modules, attachment of module connections	Screwing with high voltage danger of circuit completion	Sophisticated screwing technology, automation with screw jacks desirable
		Assemble at 40-50% charge
		Self-tapping screws
End-of-line test	Uniform charging and testing of all cells	
	Leak tightness involves high pressures, dangers of burst	

Pack Assembly: Fault identification and troubleshooting



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