TECHNICAL REPORT

I-CAR NEW ZEALAND

THE ELECTRIC VEHICLE "REVOLUTION"

- Interesting Facts & Figures About Electric Vehicles - Part 2

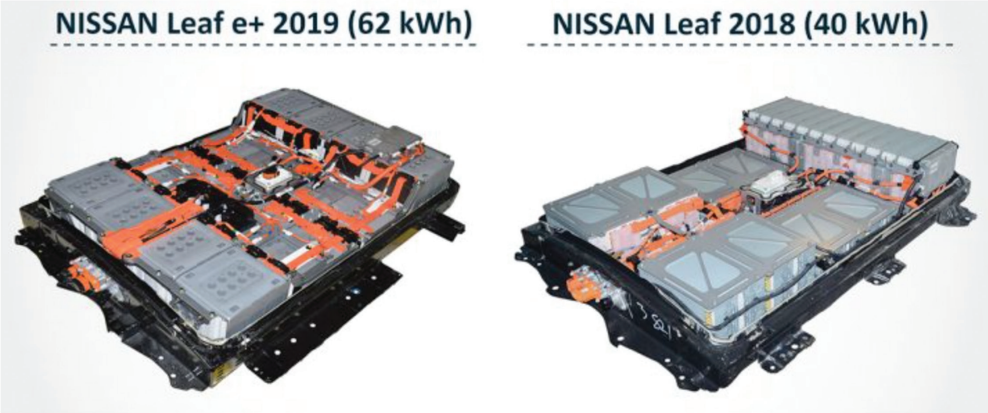
Continuing on from Part I of our technical report, where we looked at the ever- increasing worldwide sales and production of electric vehicles in their various formats, Part II focuses on battery technologies, component parts and their functions.

The High Voltage (HV) battery:

Irrespective of the type of electric vehicle – whether it be Battery Electric (BEV), Hybrid Electric (HEV), Plugin Hybrid Electric (PHEV) or Fuel Cell Electric (FCEV) all have some type of HV battery - often referred to as a "Traction Battery". As the output or capacity of these batteries has increased, so has the dimensional size and weight, and in many instances, the general location within the vehicle. Voltage output can vary greatly between vehicle manufacturers – this is also the case with varying model platform specifications and the year of manufacture, within the OEM :-

Toyota XW20 Prius (2nd generation) – Max Voltage Output = 200 V

Toyota Prius XW50 (4th generation) – Max Voltage Output = 650 V

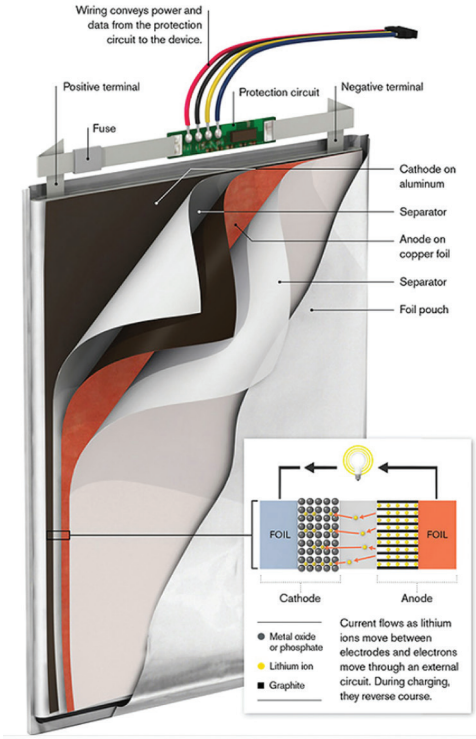


Battery power & storage materials:

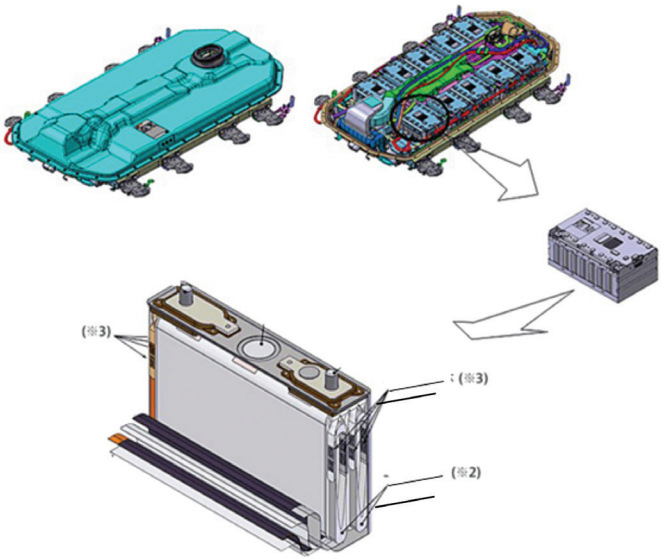
Most High voltage batteries now use Lithium Ion (Li–ion), rather than Nickel Metal Hydride (NiMH) as the power storage material – with the exception of Toyota who still use NiMH (as well as Li-ion), as an option for their HV batteries.

The Lithium Ion battery cell – how it discharges (and charges) energy:

HV batteries are actually groups of small low voltage individual cells that are grouped into modules - these are wired in series to create the battery "pack" that ultimately generates high voltage output.



Mitsubishi Outlander PHEV –



80 Lithium-Ion cells coupled together to generate over 300 volts -

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Comparing Li-ion and NiMH in automotive applications:

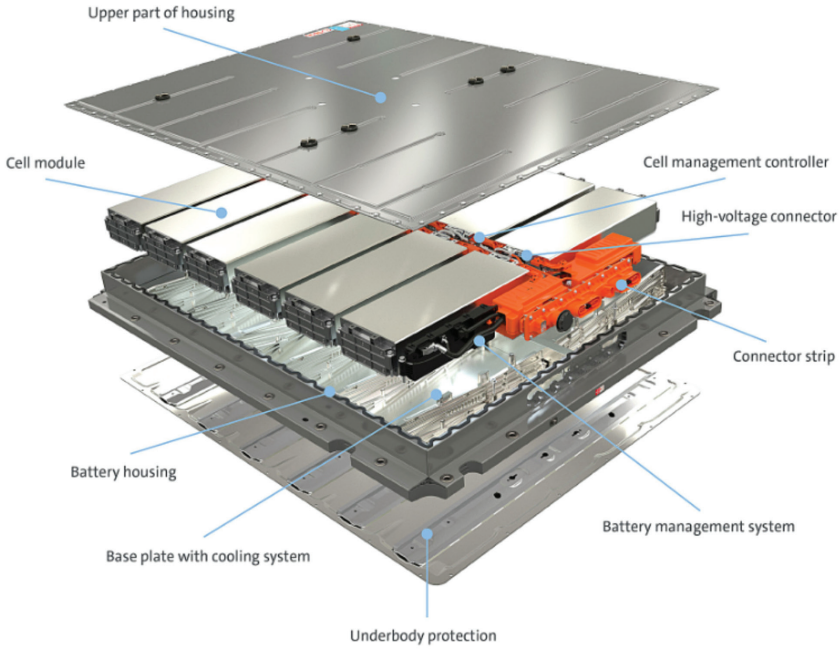
- ***Reduced weight*** – NiMH batteries are larger and heavier than Li-ion units.
- ***Power*** - While Li-ion and NiMH batteries hold similar amounts of power, Lithium Ion cells can be charged and discharged more rapidly – lowering charge times, while increasing performance.
- ***Capacity*** – Li-ion has less "memory effect" – NiMH batteries suffer from reduced energy capacity after repeated recharging when the battery is only partially discharged.
- ***Durability*** – Li-ion batteries do not last as long as NiMH units in extreme temperature environments – particularly very hot climates.

** ***New chemistry and cooling system technologies are now addressing this short-coming.***

The average weight of a modern HV battery assembly is over 230 kilograms
(The Tesla model S battery pack weighs in at **540 kgs**)

Courtesy of Volkswagen Group –

The battery case is typically made up of a combination of a metal frame (steel or aluminium), and plastics/composites…..



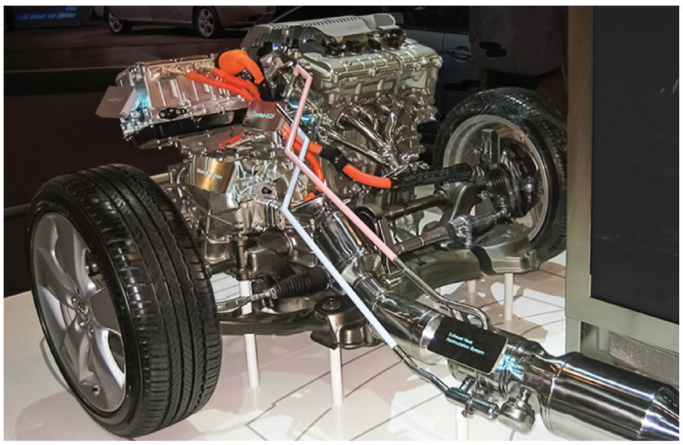
Cooling and heating systems:

HV batteries perform most effieciently under "normal conditions" - best described in the same context as the optimum conditions for human activities: "Room Temperature" of around 21 C.

The HV battery requires warming up as quickly as possible in cold conditions to opeate/perform efficiently, as well as having the heat generated by the discharge and recharge processes monitored/controlled for the same reasons – additionally, heat output must be controlled to prevent "thermal overload" that could result in the battery catching fire.

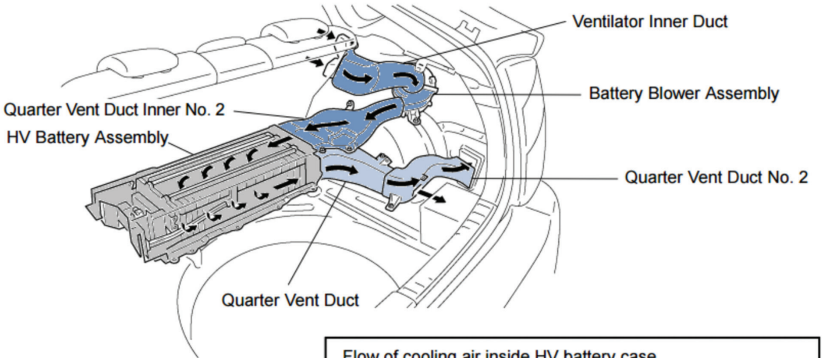
Heating systems (for HEV & PHEV):

Exhaust Gas Recirculation (Toyota Prius shown)



Positive Temperature Co-efficient (PTC) heaters (for EV's).

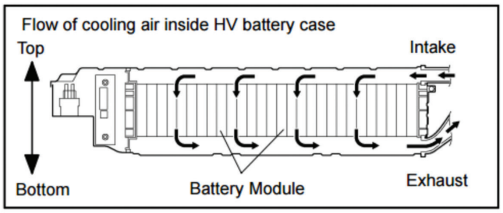
These heat the coolant of the HV battery, and also serve as the heating system for the interior (cabin heating) of the vehicle.



Cooling systems (BEV / HEV & PHEV):

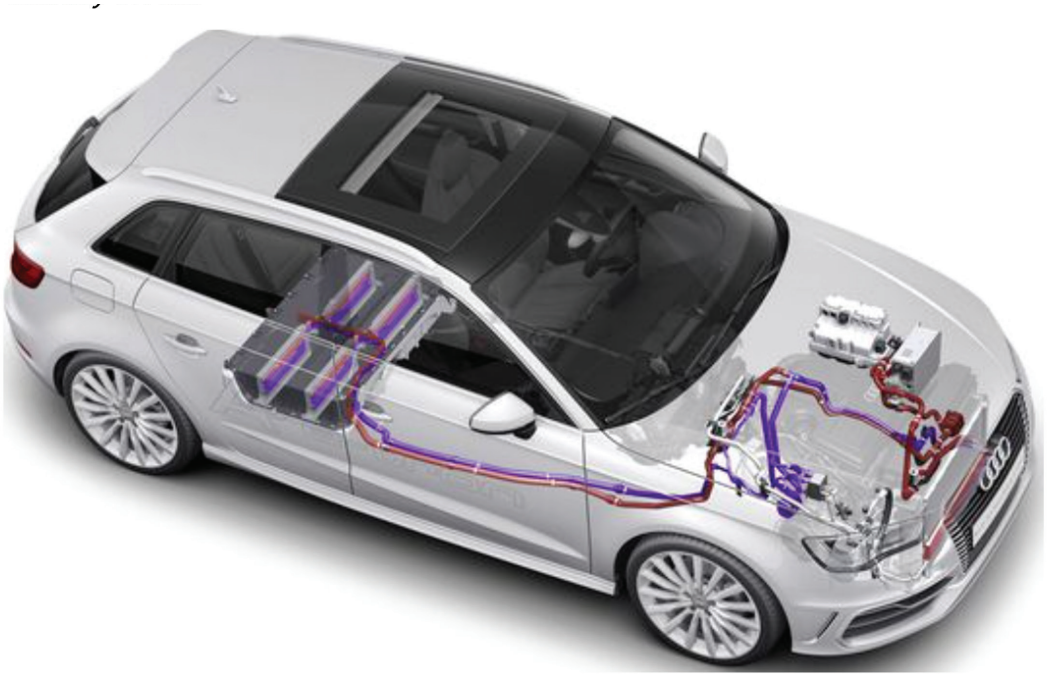
Fan only cooling – Conventional electrically driven fan(s) blows cold air in and around the battery enclosure via inlet and exhaust ducting

: Cooling Air Flow

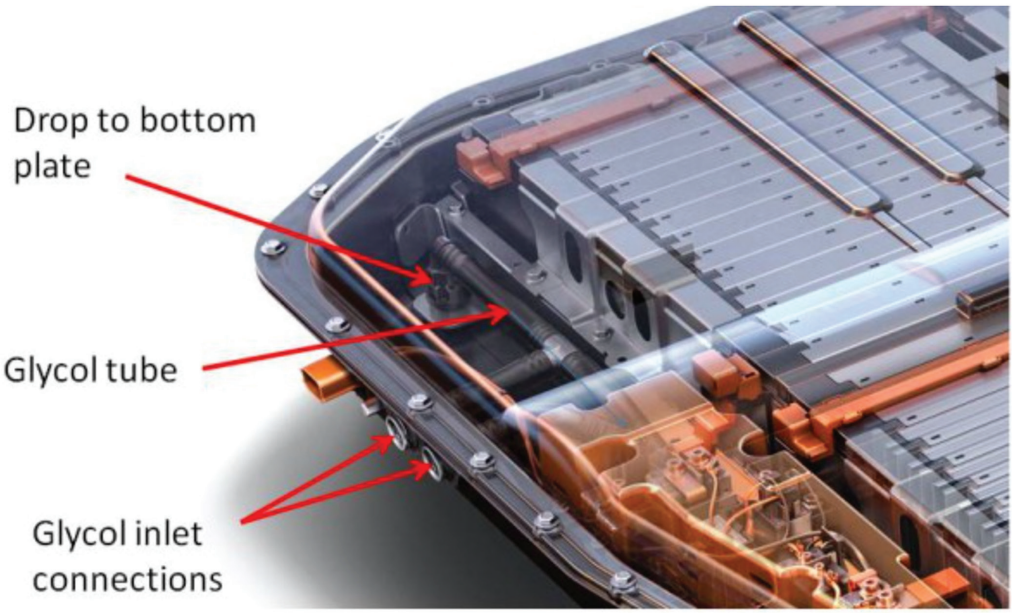


Liquid cooling (HVAC system) - A portion of the vehicle's A/C system is dedicated to controlling battery temperature.

Courtesy of Audi



Liquid cooling using conventional glycol-based inhibitor/coolant systems -



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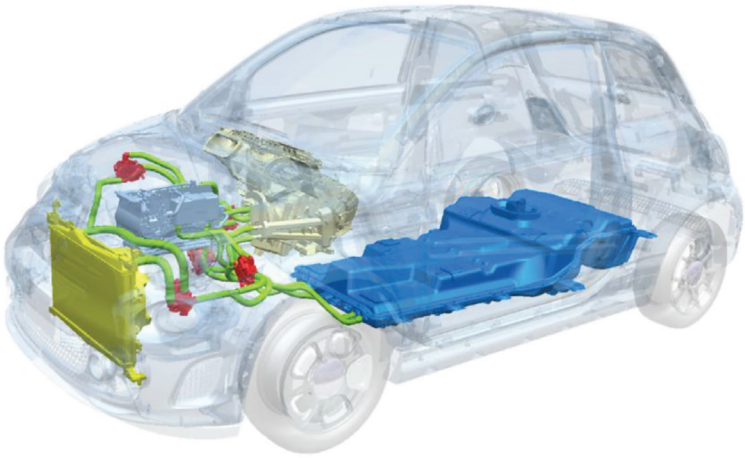

A review of some of the common safety features found on electric vehicles:

1. Most High Voltage (HV) components, including cable insulation / sheathing, plugs & connectors, pictograms & wiring are coloured ORANGE – However, there are exceptions to this. Dangerous voltage levels are those above 55 V (AC & DC).

2. HV batteries and associated parts of the HV system are described as a “floating system” - in that they do not connect, or tie in directly with the vehicle body. There remains a risk that dangerous levels of energy can still be transferred electro-magnetically through the converter.

3. While the conventional 12 volt system controls the HV system, capacitors inside the converter in the drive train can hold the whole HV system live without a 12 volt battery fitted.

4. Some HV batteries have a SERVICE DISCONNECT which isolates the battery from other HV parts like the inverter / converter, control modules etc. However, the capacitors in some inverters can hold a full charge for days or even weeks.

As safety is of paramount importance when working with any electric vehicle, ALWAYS follow the manufacturer’s recommendations / requirements, in the first instance.

These articles have been written by Martyn Lane: I-CAR Instructor, Weld Test Administrator and Technical Specialist to the auto body industry