Green Mobility
Driving Lithium Battery revolution

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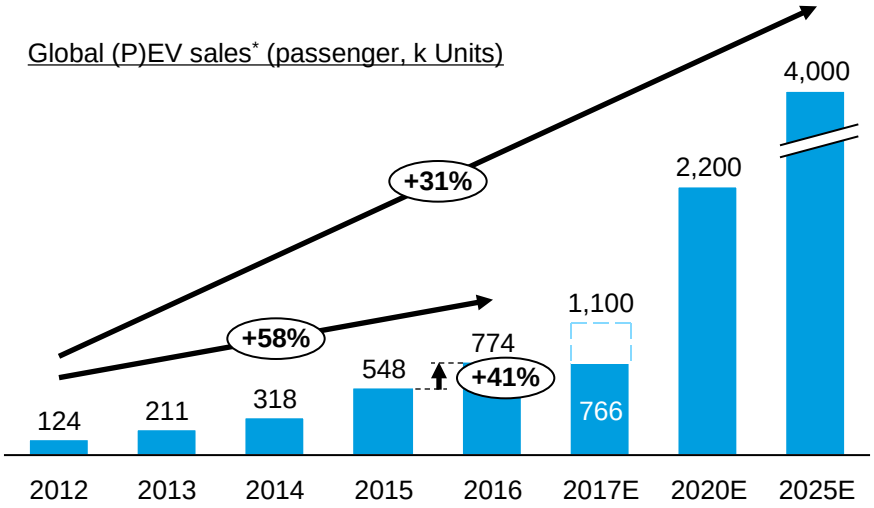
Agenda

- Global xEV & Battery Market in 2016 and Future
- Future Challenges & Drivers: Cost & Mileage
- Global xEV Policies/China New Credit Policy
- Solvay in Li-ion Batteries
- Current Battery Technology and Path Forward

Global xEV Sales: High Growth & Regional Concentrated



- From 2012, the global xEV market paced into the fast lane with annual CAGR nearly **60%** up to 2016 with the sales of 774.4 k units (1 M incl. commercial EV)**.
- In 2016, the EV penetration rate firstly hit **1%** of the global passenger vehicle market (77.3M).
- China, EU, US and Japan takes up to **97.5%** of the global EV market.
- Regionally, China & US achieve the highest growth rate while decreased in Japan.
- YTD Sep2017, the xEV passenger sales already reached >760k units, expect to exceed **1M** for the first time.

Total Sales	351,861	222,619	158,455	22,375
M/S	45%	29%	20%	2.9%
YoY Growth	↑ 69.7%	↑ 15.1%	↑ 37.4%	↓ -11.7%
Penetration rate	1.45%	1.5%	0.9%	2.9%

* Source: EV sales, world round data
** Source: ACEA

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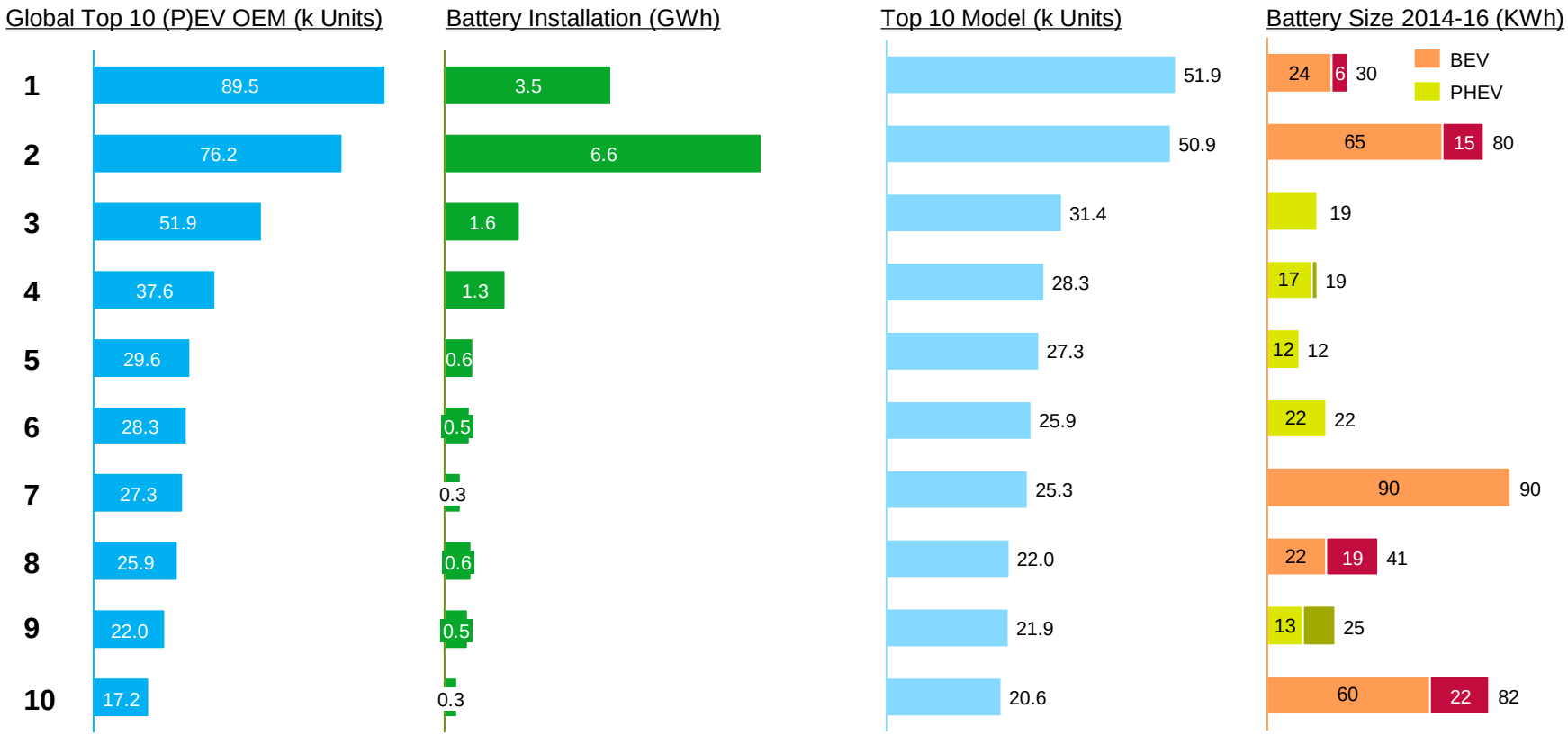
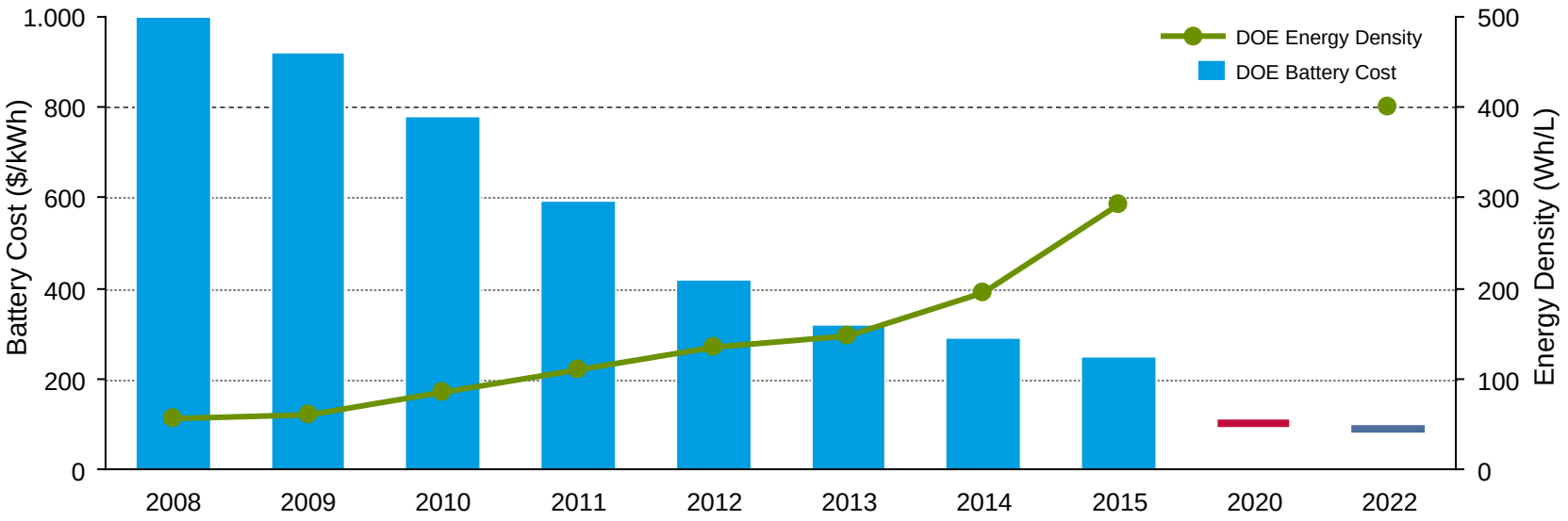
2016: BEV & PHEV Hang in the Balance*



- Battery Size: **Higher demand of mileage** (energy) pushed for higher energy for **BEV**, while PHEV stays due to its satisfactory fuel economy and mileage.

* Source: various source of xEV sales, battery size from public information

2 Main Drivers for Future xEV Market Growth: Cost & Mileage

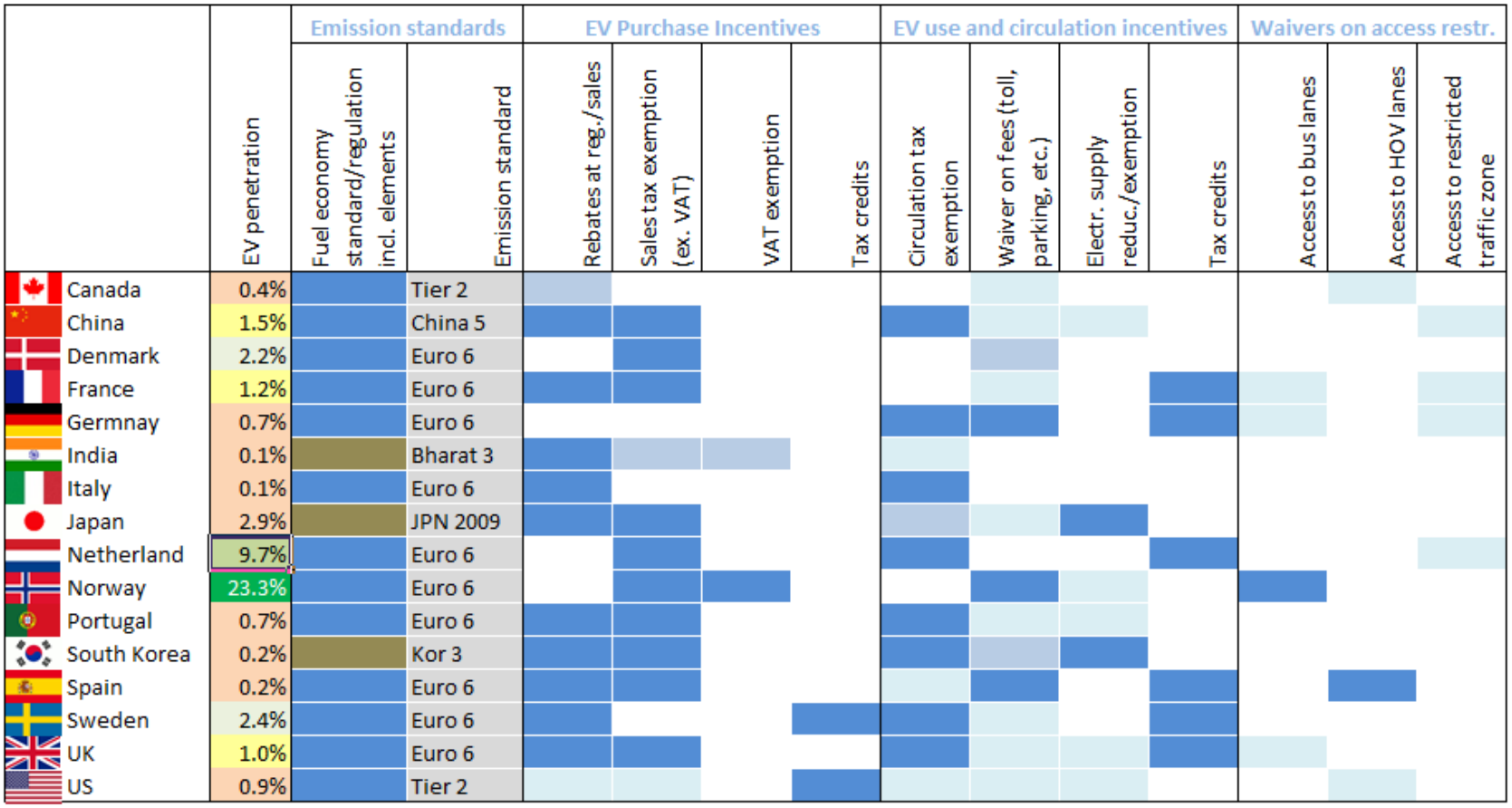


The development of battery energy density and cost over the past decade gives encouraging signs on the possibility to meet targets defined by OEMs

- Battery costs have been cut by a factor of four since 2008 to 2015 (**1000 to 268 $/kWh**) and are set to decrease further, with Industry target of ~100 U$/kWh by 2020 and <100 $/kWh by 2022
- Battery energy density esp. for BEV needs to increase to enable longer ranges for lower cost.
- **Technological progress** and **economies of scale** are critical to move towards cost parity with conventional internal combustion engines (ICEs). Recent OEM announcements suggesting EV ranges that will mostly soon be exceeding 300 km give encouraging signals for the future

* US DOE (2015 and 2016) for PHEV battery cost and energy density estimates; EV Obsession (2015); and HybridCARS (2015).

Geographical Policies to Support the xEV Market



Targeted policy*

Widespread policy**

National policy

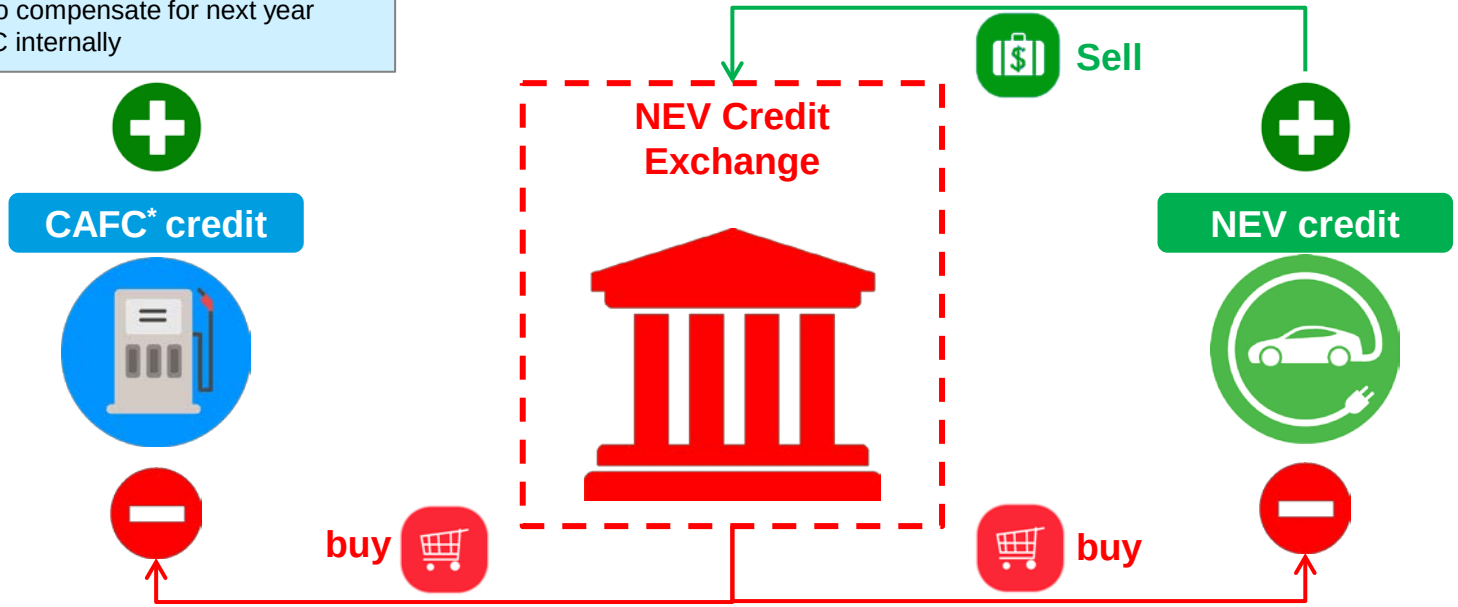
General fuel standard
Indirectly favor EV deployment

- Emission standard is the main driver for implementation of xEVs, to ensure the sustainable growth of the industry, all policies released by central & local governments, including: financial incentives, circulation incentives, waivers on access restrictions

* Policy implemented in certain geographical areas
** Policy implemented in a widely spread geographical areas

China : New CAFC & NEV Credit Management Policy

CANNOT be traded to other OEM, but to compensate for next year CAFC internally

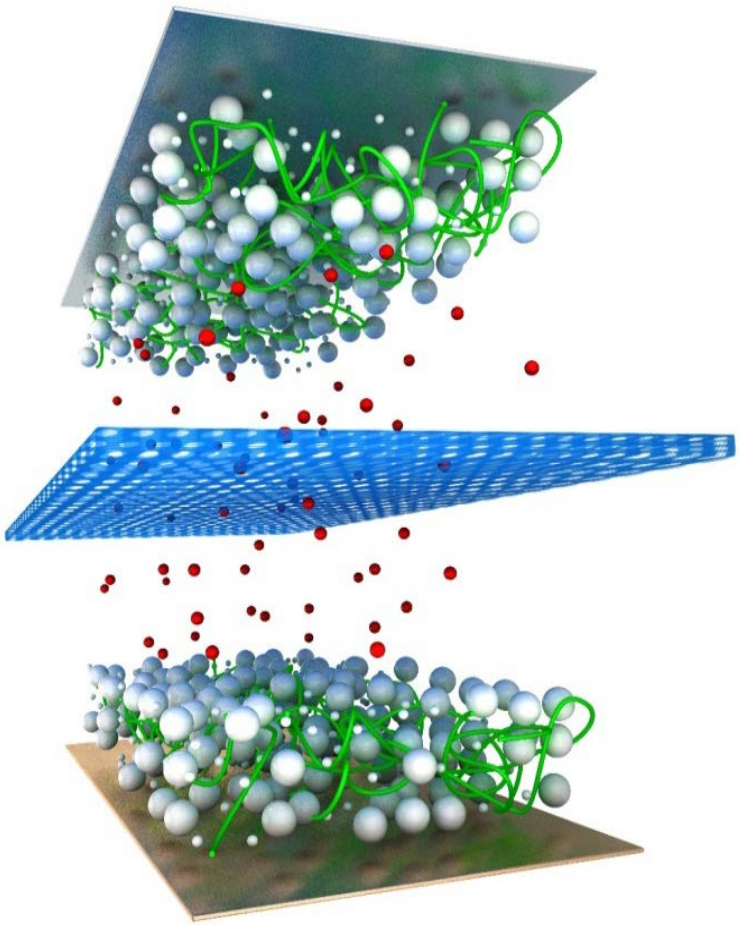


Or:

- Balancing transfer from last year CAFC credit (+)
- Compensated by NEV credit
- Transfer from affiliated company (>25% share)

* CAFC: Corporate average fuel consumption

Solvay Material Solution in Li-ion Cells: binders and separators



High Performance Cathode Binder

- Good processibility
- High Ni cathode compatible (anti-gelation)
- Ultra high adhesion
- Flexible grade available

Solef® PVDF

PVDF Separator Coating

- Solvent & Water based available with good processibility
- Excellent lamination with electrode
- Outstanding chemical resistance vs. electrolyte
- Faster & complete wettability

Solef® PVDF

High Performance Anode Binder

- High lamination with coated separator
- Low swelling in Electrolyte
- Lower Ri
- Good anode flexibility

Solef® PVDF
Torlon® PAI

High Performance Si-based Binder (R&D)

Cell Gasket

- Good sealing performance
- Chemical resistance to electrolyte

Hyflon® PFA
Ryton® PPS
Tecnoflon® FKM

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Solvay Material Solution in Li-ion Cells: electrolyte ingredients

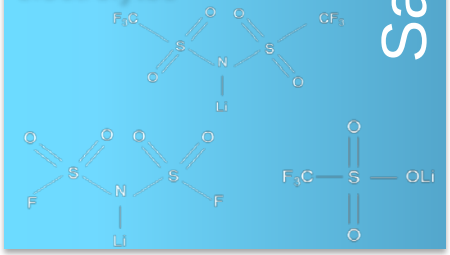
We provide electrolyte ingredients with a **large porfolio** of fluorochemical materials for **Advanced Li-ion** batteries and **Next generations** of batteries (Solid state, Li sulfur, Na-ion)

PURITY

Salts

LiTFSI, LiFSI, LiTA

Lithium salts for electrolytes



STABILITY

Additives

F1EC, F2EC, SA series

Fluorinated additives for electrolytes

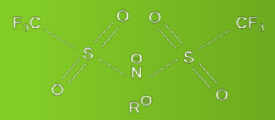
trans-F2EC

SAFETY

Ionic liquids

TFSI ILs

Ionic liquids based on TFSI for HV Li-ion electrolytes



PERFORMANCE

Formulations

Energain™

Fluorinated solvents & formulations for HV electrolytes

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Solvay Material Solution in Li-ion Battery Module/Packs

Metal Replacement

- High mechanical robustness
- Good chemical resisitance
- Flame retardant
- Dimensional stability

Ixef® PARA
Amodel® PPA
Ryton ® PPS

HV Components

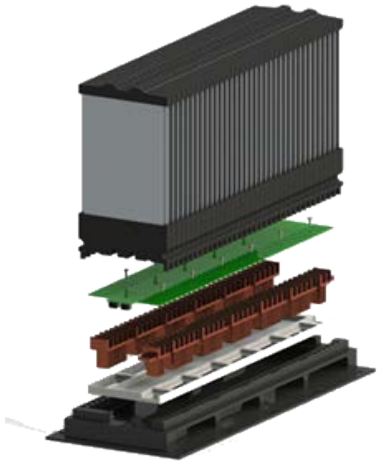
- High CTI (up to 600V)
- Chemical resistance
- Flame retardant
- Color maintenance

Amodel® PPA

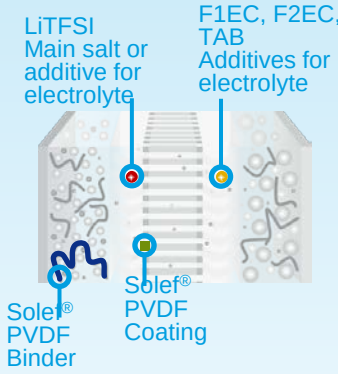
Cooling Agents

- Inflammability
- Excellent electrical insulation
- Low/high T viscosity
- High cooling efficiency

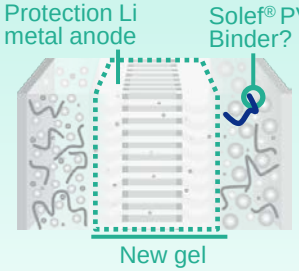
Galden® PFPE

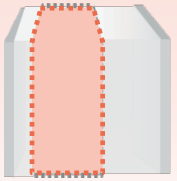


Solvay Technology Roadmap: From Li-ion to Solid-state



New pre-formulation electrolytes
New salt
New solvents
New additives





New gel and solid electrolyte (including separators)

HORIZON 3

- Technologies for LiS
- Solid Polymer Electrolyte
- Solid Inorganic electro

HORIZON 2

- New ingredients, Blends for High Voltage (HV) electrolyte
- Protection Li metal anode
- New Gel Electrolyte

HORIZON 1

- Binder for cathode
- Binder for anode
- Coating for separators
- Polymer solutions for Battery pack/modules, gaskets

Safety Data Sheets (SDS) are available by emailing us or contacting your sales representative. Always consult the appropriate MSDS before using any of our products.

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