



# Li-ion Batteries: challenges and opportunities

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PANEL: The Challenges of Electrification

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# Outline

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## 1 Availability of Raw Materials

- Critical RM – Cobalt, graphite
- Lithium (not critical, but difficult to extract from hard-rock materials)
- Circular economy / recycling

## 2 Safety






- Main causes of failure
- Thermal runaway
- Safety issues: monitoring and protection

## 3 Performance and Cost

- New materials for electrodes/electrolytes
- Cost reduction

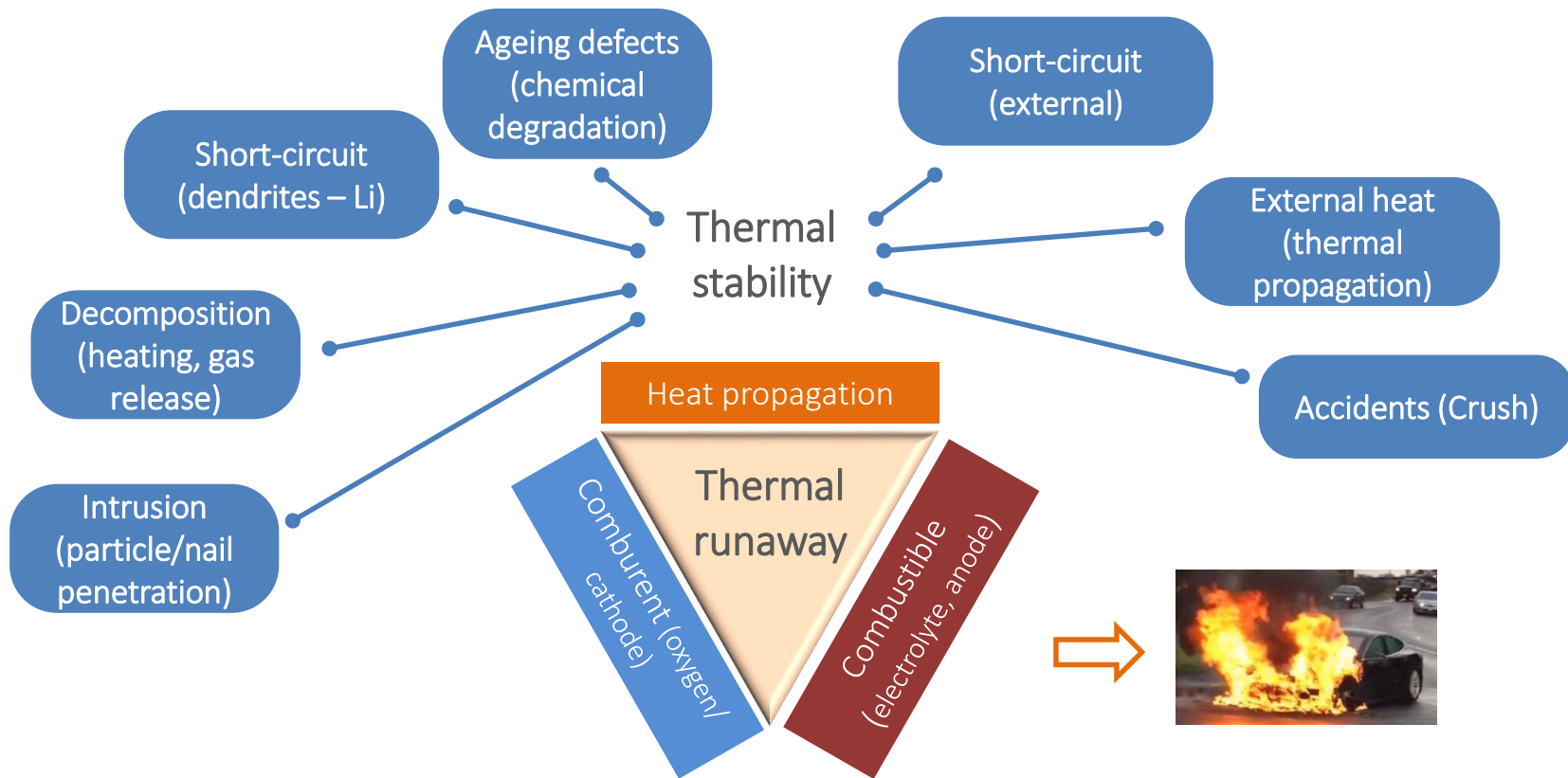
## 1

## Availability of Raw Materials

Acronym		LCO	NMC	NCA	LMO	LFP
Cathode		$\text{LiCoO}_2$	$\text{Li}(\text{Ni}_{1/3}\text{Mn}_{1/3}\text{Co}_{1/3})\text{O}_2$	$\text{Li}(\text{Ni}_{0.8}\text{Co}_{0.15}\text{Al}_{0.05})\text{O}_2$	$\text{LiMn}_2\text{O}_4$	$\text{LiFePO}_4$
Anode		Graphite	Graphite	Graphite	Graphite	Graphite
Metal contents in cell (wt%)	Li	2.2	2.2	2.2	1.2	1.4
	Co	19	6.2	2.7	-	-
	Ni	-	6.2	14	-	-
	Mn	-	5.7	-	19	-
	Al	-	-	0.4	-	-
Availability Risk		High (high Co %)	Medium	Medium-low	Low	Low
Main applications						

## Challenges on Materials Availability

- Substitution of critical materials
- Recycling towards circular economy
- Design for sustainability (improve dismantling, ...)



## Safety Challenges: mitigation measures

### Thermal propagation prevention by:

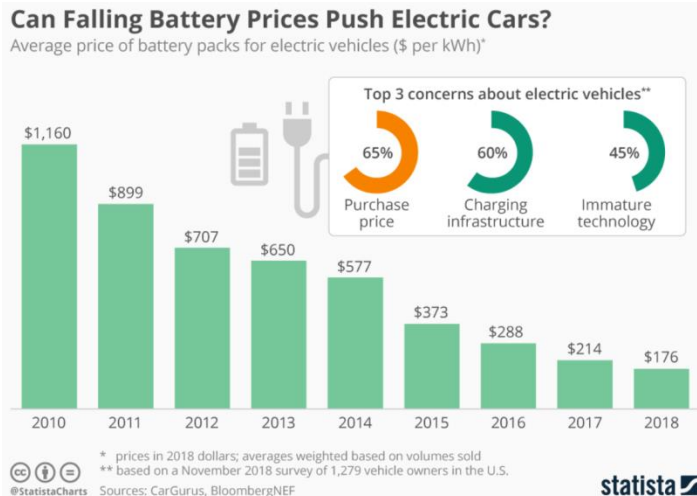
- Heat sinking systems (heat dissipation)
- Monitoring of heat/voltage/current for failure detection
- Mechanical crash protection
- Cell insulation by plates/foils/foams (ceramic materials, etc)
- Emergency cooling systems and fire protection materials: Intumescent, PCMs, flame retardants

Performance improvement and cost reduction by:

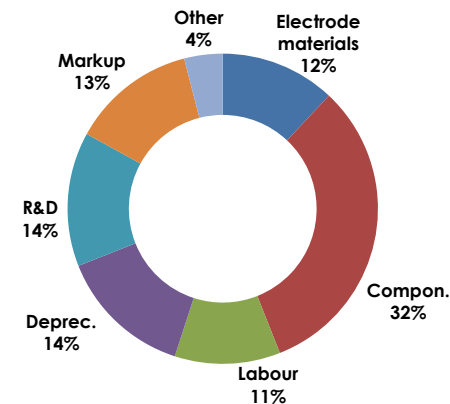
New materials (anodes, cathodes, electrolytes) to improve properties:

- Capacity
- Energy density
- Autonomy
- Charging rate.

Battery costs



Battery Cost Breakthrough



**THANK YOU!**