



North America 2025 Conference



Foam Expo

“Innovations in Thermal Management: Cooling Technologies for EV Batteries”

Abishek Kanagali

Thermal Engineering Manager CAE



Exterior
Plastics



Interior
Plastics



Mechanical
Assemblies



Exterior
Metals



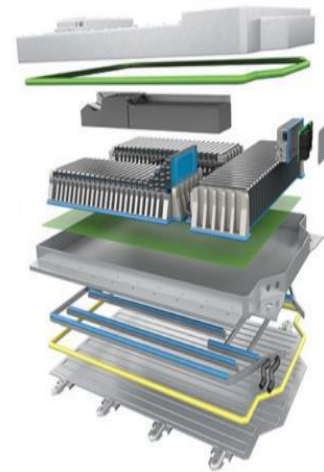
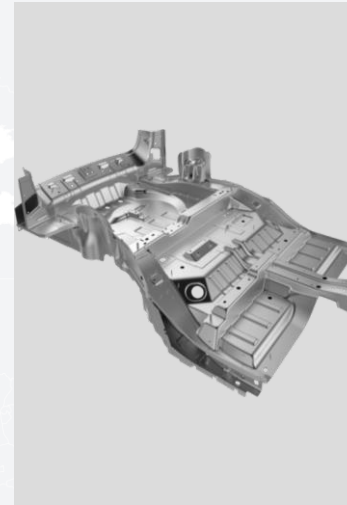
Metal Body
Structure



Lighting
Systems



Battery
Innovation Center



FLEX-ION



HQ



+26 000
Employees



9
Countries



6,6
Billion in
revenues



75
Production &
R&D Centers



FlexPanel[®]
PC Glazing with integrated
graphics



PC Glazing with integrated
graphics



Flex F/X[®] Lighting through
body panel
Integrated messaging



B-Pillar with integrated

Abishek Kanagali

FlexPanel 3D[®]
Lit Grille effects

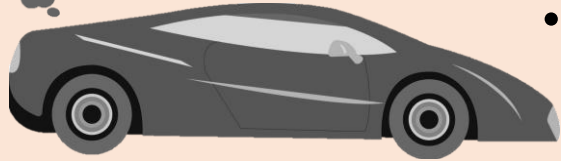


ADB Forward
Lighting



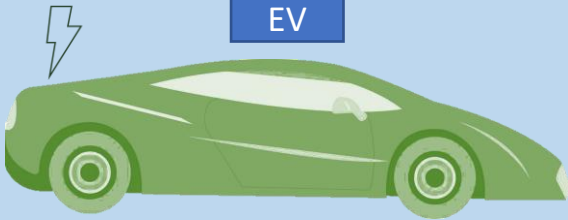


ICE



- About **80%** of original energy loss is through heat produced by IC engines, drivetrain, mechanical friction, etc.

EV



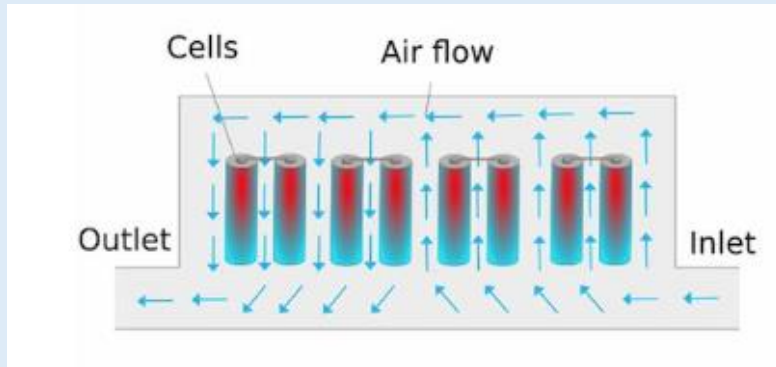
- About 35% of original energy loss through drivetrain, powertrain cooling, etc.
- 20% is re-captured by brakes and fed back to battery, **effectively** only **15%** of energy is lost in EVs.

- **Thermal Management** is the major factor for BEV's performance as it affects **range** and **safety** of the EV. (even though they are more energy efficient compared to ICEs)
- **Optimal Battery temperature is between 20C-35C**
 - Lower temperature drops the charging-discharging ability.
 - Higher temperatures can damage cells including thermal runaway
 - Maintaining temperature delta within the cell is also critical.





Air Cooling



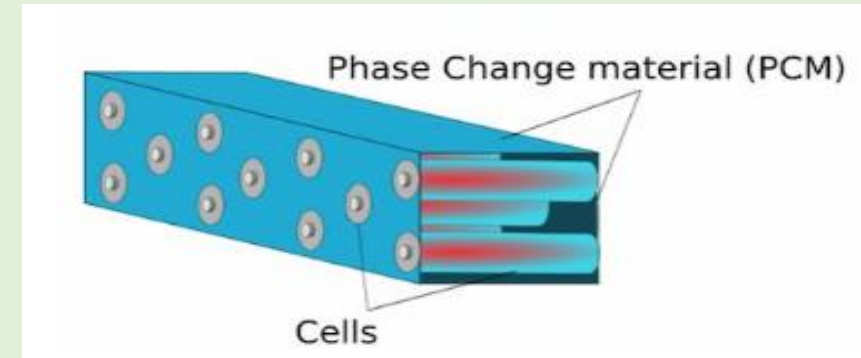
Advantages

- Simple design
- Light weight
- Low cost
- Easy Maintenance

Disadvantages

- Low Thermal conductivity
- Limited Thermal capacity
- Sensitive to ambient conditions
- Suitable for smaller HEVs

Phase Change Materials (PCM)



Advantages

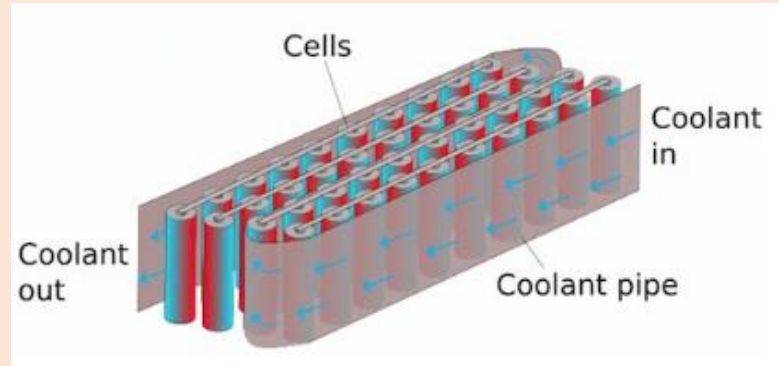
- High Thermal capacity
- Superior Temperature uniformity
- Low energy consumption
- Cost effective

Disadvantages

- Low Thermal conductivity
- Fast charging issues
- Issues with Volumetric expansion
- Leakage



Liquid Cooling (indirect)



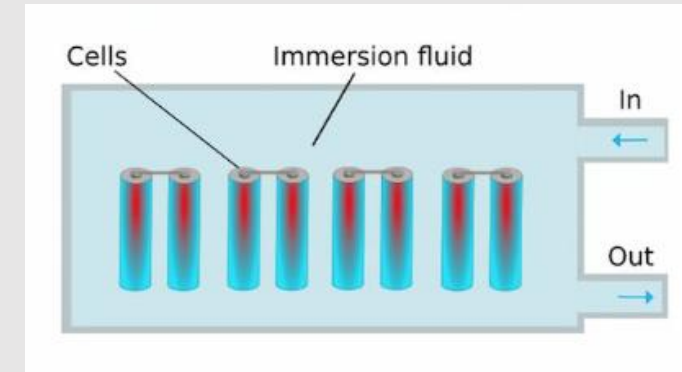
Advantages

- High Heat capacity
- Reliability
- More efficient and less maintenance

Disadvantages

- Lower Cooling efficiency
- No temperature uniformity
- High Cost
- High Thermal resistances

Immersion Liquid Cooling



Advantages

- Better capacity retention
- Temperature homogeneity
- Reduced fire risks
- Higher Charging rate possible

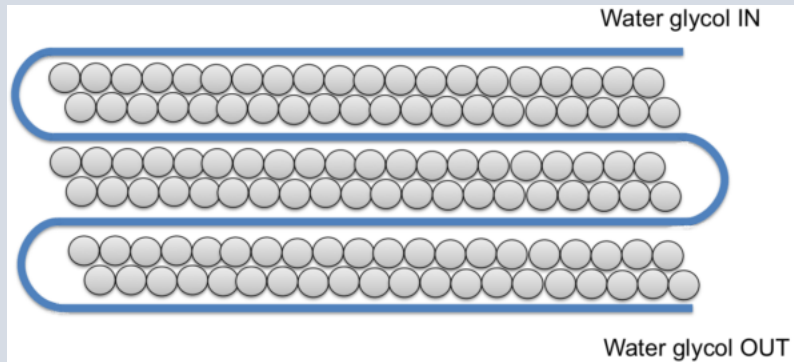
Disadvantages

- Potential for leaks
- Space and Weight constraints
- High maintenance and upfront cost



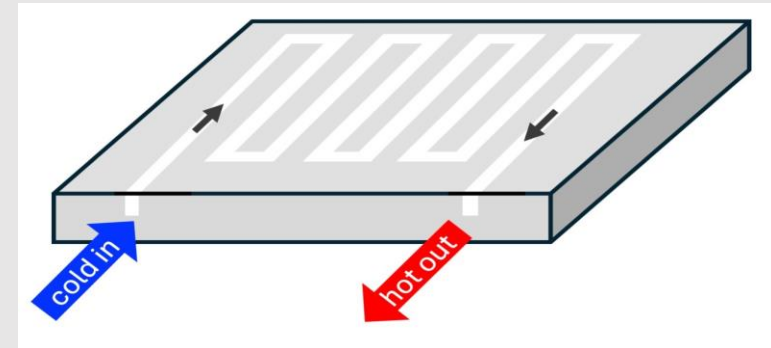
Liquid Cooling (indirect)

Side Cooling



- Ideal for taller cells ↑
- Better temperature uniformity ↑
- Increased complexity and weight ↓
- Busbar design constraints ↓

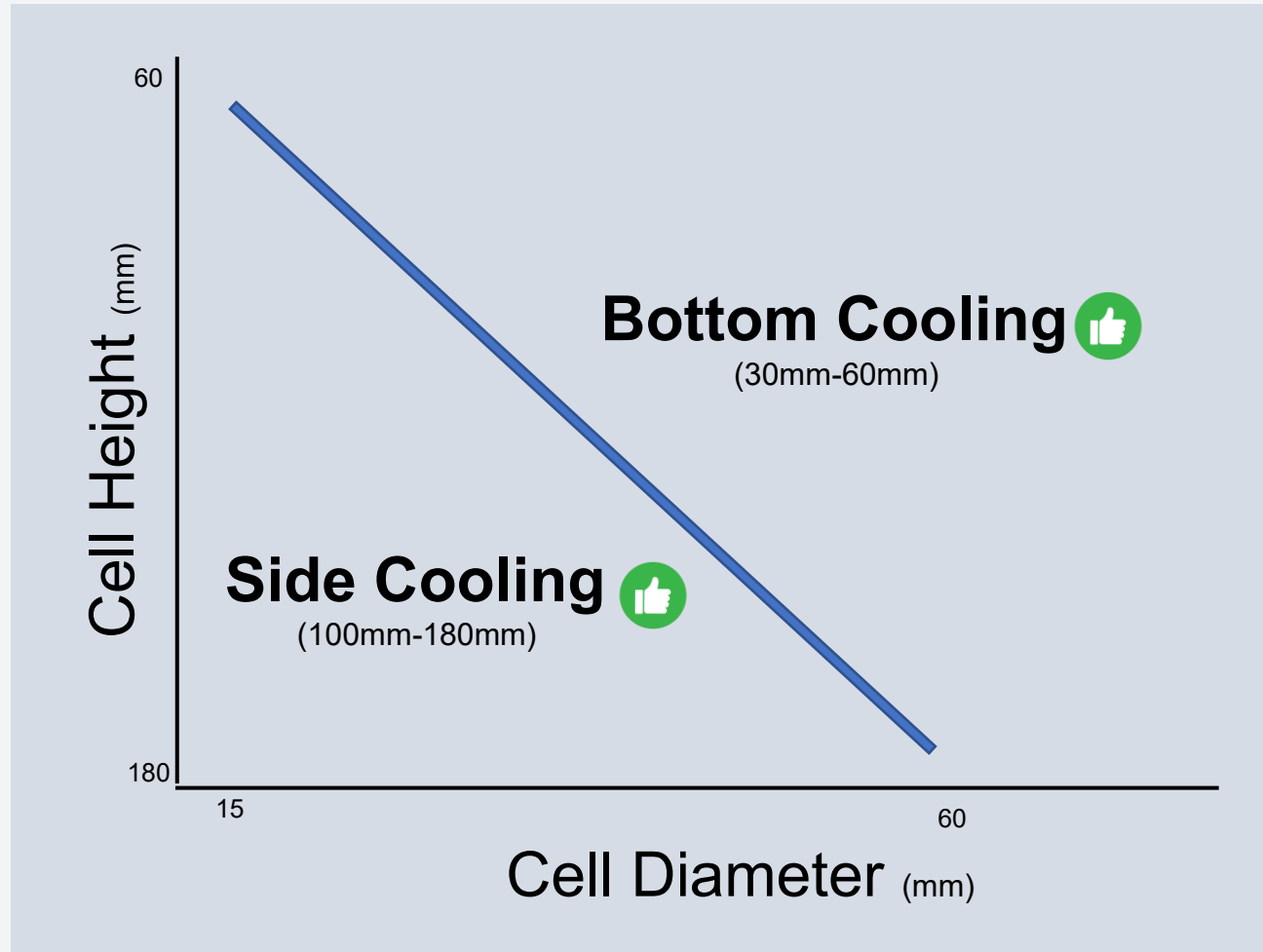
Bottom Cooling

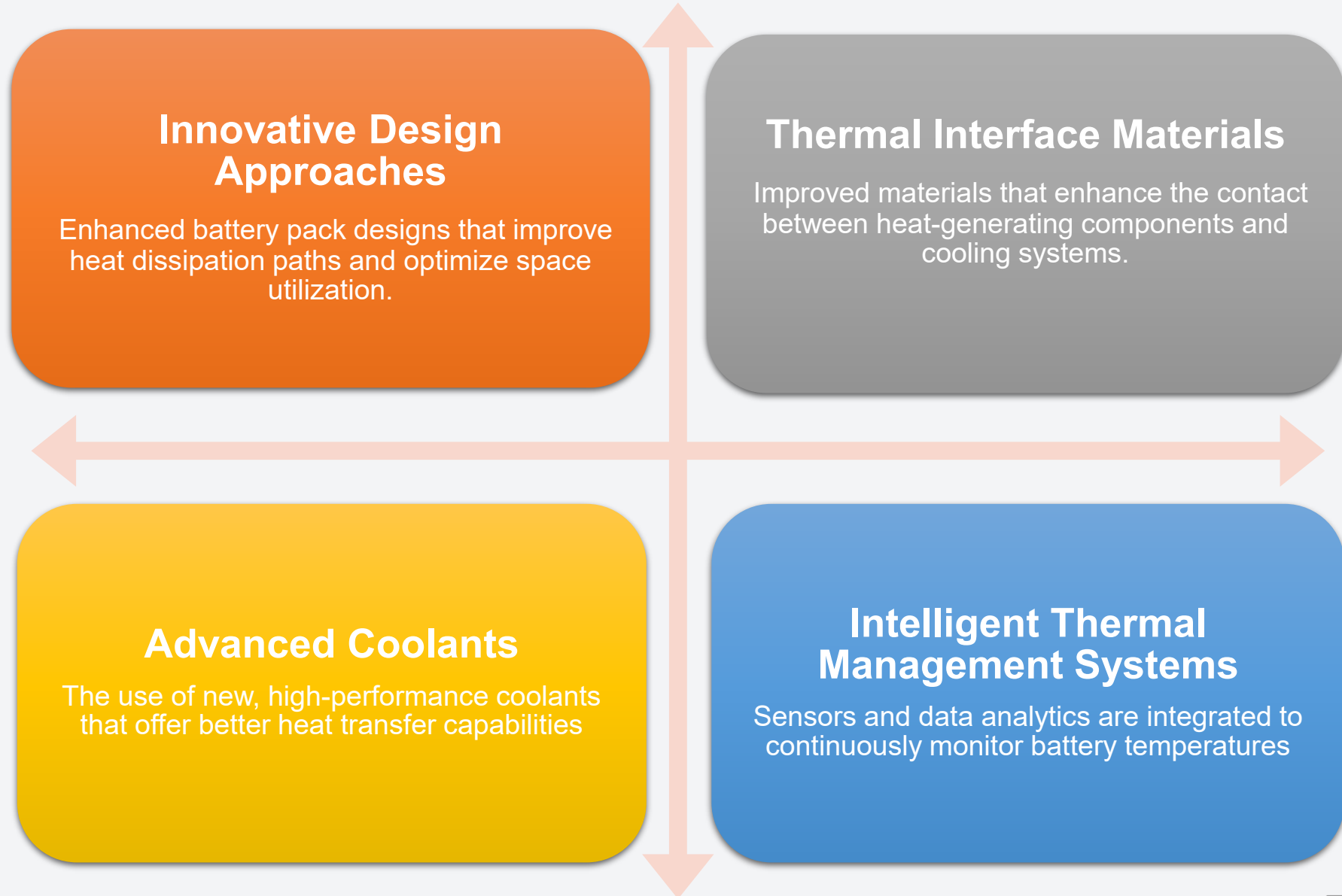


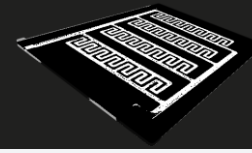
- Ideal for wider cells ↑
- Structural simplicity – manufacturing ↑
- Reduced risk of coolant leaks ↑
- Rely on axial thermal conductivity ↓
- Poor temperature uniformity ↓



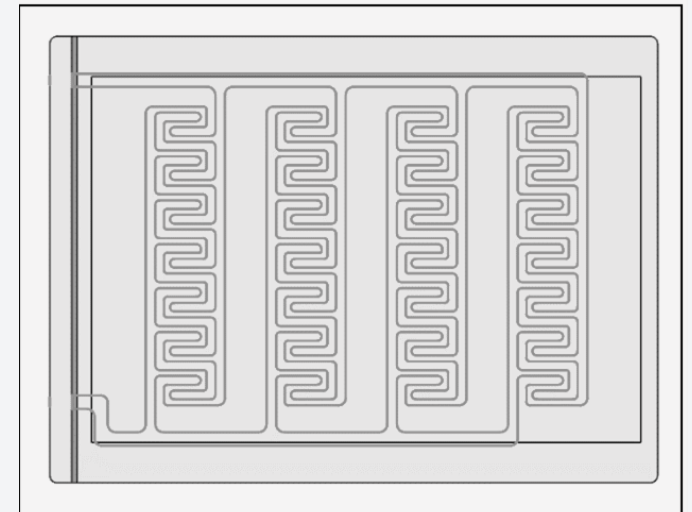
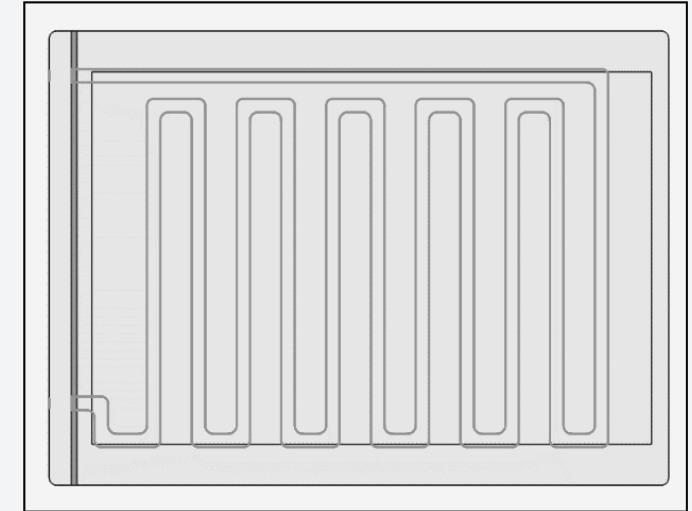
Liquid Cooling (indirect)





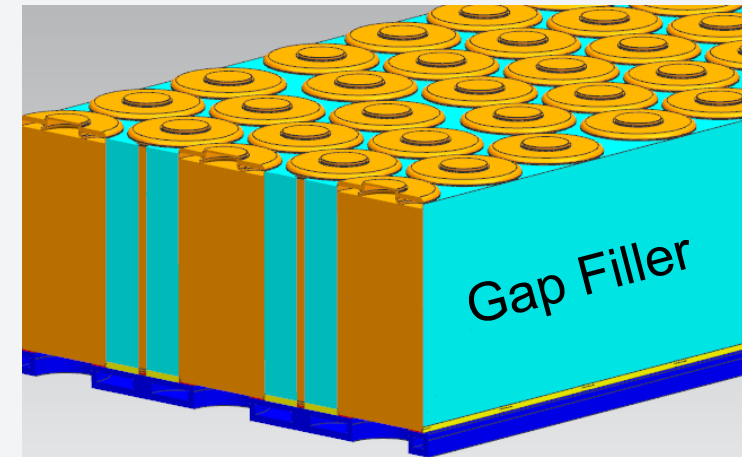


- Optimizing cooling plate channels – strategic design
 - Flow path optimization
 - Use microchannels to enhance heat transfer
- Higher conductive material casing
- Adding grooves and fins
- Advanced cooling fluids – including nanofluids
 - Adjusting flow rates
- Surface treatment like anodizing, electroplating





- Transfer heat across interface between battery packs and cooling plates.
- Electrical insulation
- Vibration damping
- Resist Thermal runaway

**Gap Filler Materials:**

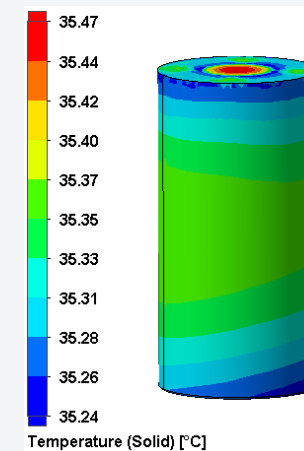
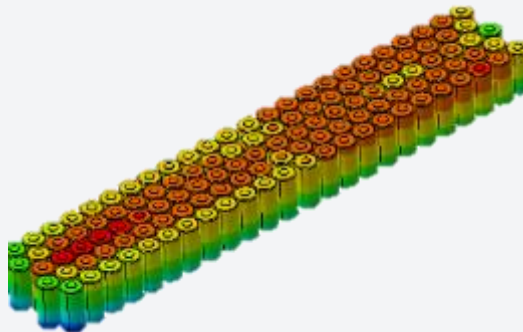
Higher conductive material
Select the optimal filler – low cost
Low uniform temperature

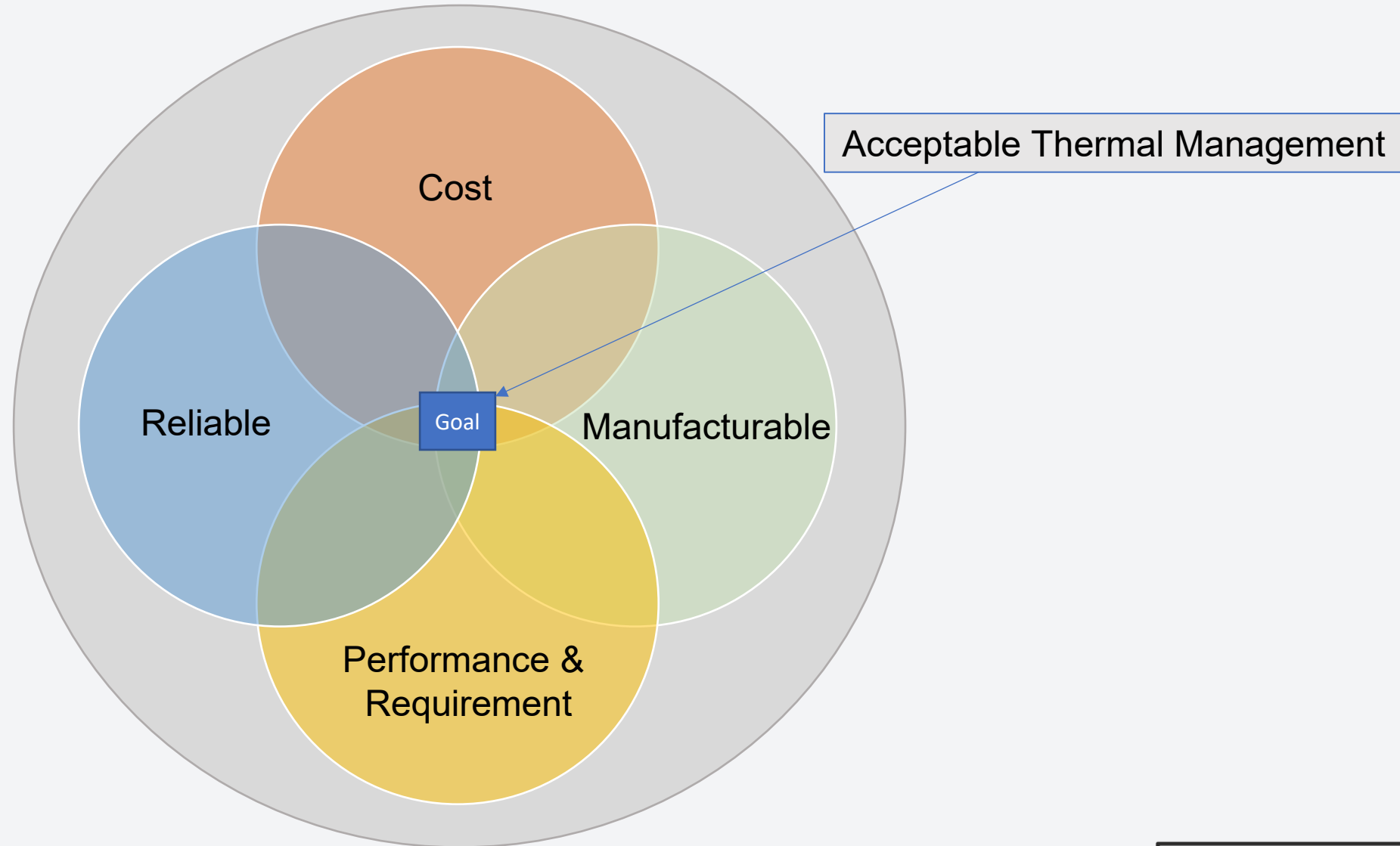
Gap Filler Thickness:

Thinner the better
Maintaining insulation
Vibration damping/mechanical



- **Risk of Thermal Runaway:** High temperatures can greatly reduce the battery's safety.
- **Decay of Battery Capacity:** The battery's electron transfer rate is faster than the diffusion rate of lithium ions. So, the positive electrode can hold fewer lithium ions. This reduces the battery's capacity.
- **Reduced Battery Performance:** High temperatures inside the pack can damage the cell structures. This includes the electrode materials and electrolytes. This damage is the root cause. It reduces battery performance and power output.
- **Reduced Cycle Times:** Charging and discharging in high-heat speeds the aging of lithium cells. This reduces their lifespan and the number of cycles they can endure.
- **Uneven Temperature Distribution:** Uneven temperatures inside the pack can lead to inconsistent reaction rates in the cells. This hurts the battery's performance and efficiency.







THANK YOU

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