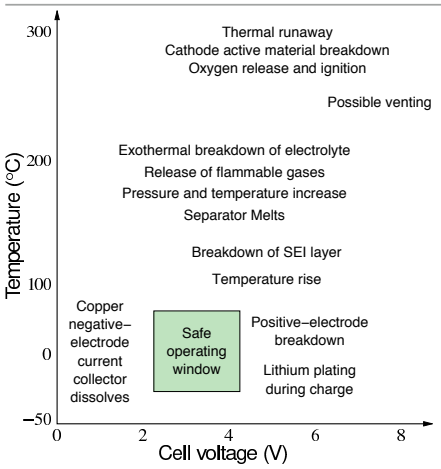
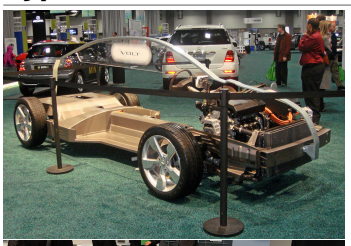
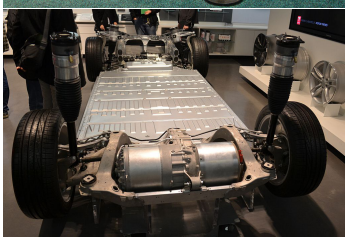
1f. Thermal control



- Won't go into detailed thermal-management control strategy in this specialization
- However, important to understand safety and life impacts of temperature
- Generally, lithium-ion cells last longest if maintained in temperature band from about 10 °C to 40 °C during use
- Important to keep *uniform* temperature across battery pack for uniform aging

Types of thermal management





- Air cooling may be sufficient, especially for EV (low rates)
- Liquid cooling may be necessary for some aggressive P/HEV applications, or range and life extension
  - Photos show cutaways of Chevy Volt and Tesla S, both of which use liquid thermal management
- Heating may be necessary to avoid charging at low temperatures—high risk of cell damage if pack is charged when cells below about 0 °C
- Active (refrigerant) cooling when vehicle plugged in may extend life enough to warrant use

Summary

- Important to keep battery-pack cells at a "comfortable" temperature to ensure safety and to extend life
- Also important to keep cells at a uniform temperature for consistent aging (also reduces need for many temperature sensors)
  - Present commercial systems use either air or liquid systems, and some reports indicate that range and life are negatively impacted by air systems
  - Active heating and cooling while vehicle plugged in can extend life, shorten charge times
- While we don't focus on it in this *algorithms* specialization, design of the thermal-management system is challenging and very important part of overall xEV design

Credits

Credits for photos in this lesson

- Chevy volt cutaway on slide 2: By Mariordo Mario Roberto Duran Ortiz (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Chevy_Volt_drivetrain_cut-away_WAS_2010_8889.JPG
- Tesla S cutaway on slide 2: By Oleg Alexandrov (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Tesla_Motors_Model_S_base.JPG