ASTON MARTIN

# Role of Testing in a Digital World

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# Overview

The purpose of this presentation is to explain, discuss and emphasize the importance of lithium-ion battery cell testing from the *electrochemical point of view*.

# Future of the Cell Technology (1/2)

- ✓ Long range
- ✓ High performance
- ✓ Fast Charging
- ✓ Safe
- ✓ Long lifespan

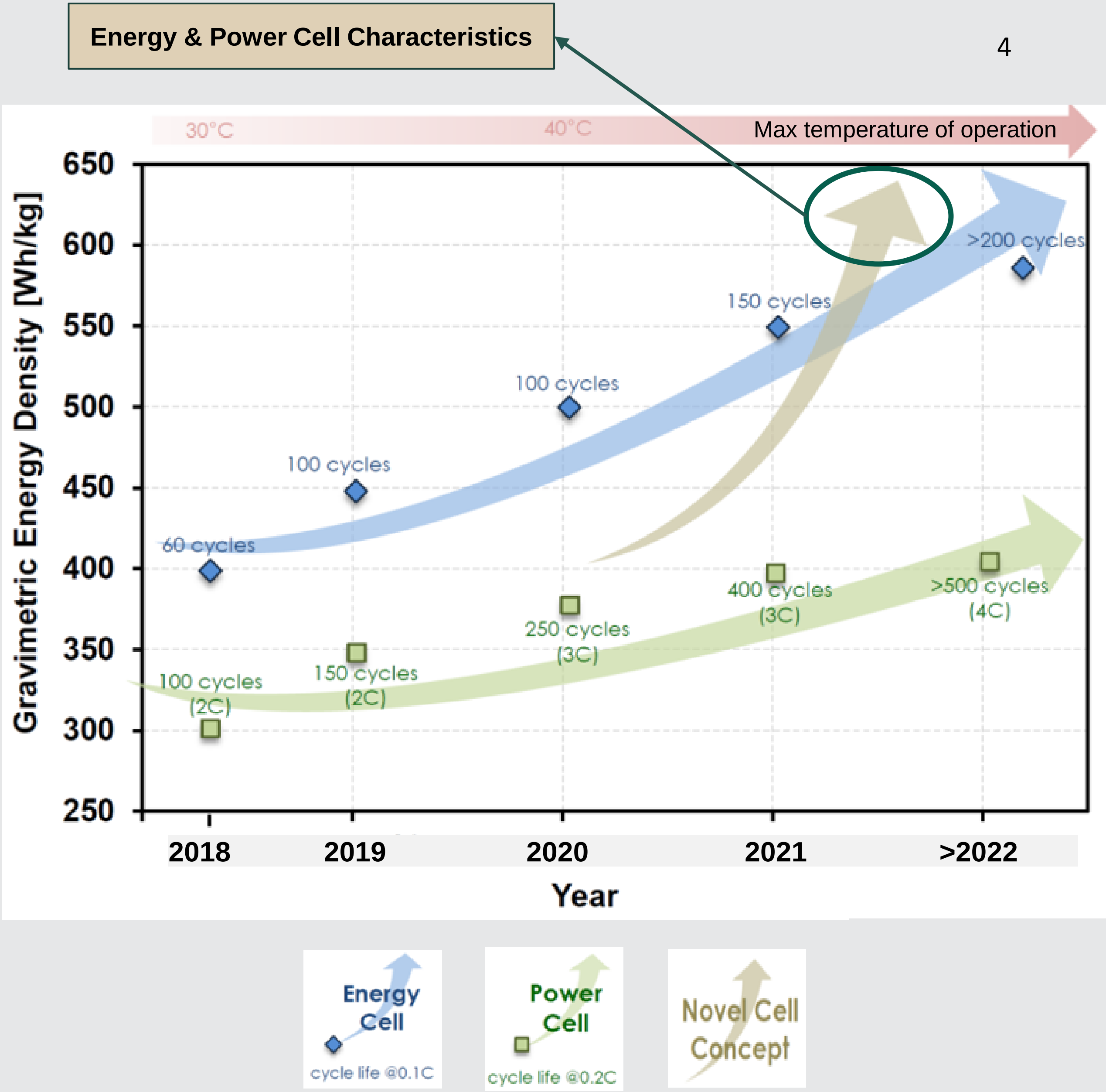
→ Energy and power dense cells that can be used safely in a wide temperature range for a long time.

↓

Importance of accurate test results!

# Future of the Cell Technology (2/2)

- Energy density = Range
- Power density = Ability to deliver high power on demand.
- $(E_g)_{Power\ Cell} < (E_g)_{Energy\ Cell}$
- <u>Goal:</u> To find a novel cell chemistry that would combine the fast charging and discharging capability of a power cell with the long-ranged energy cells.
- As shown in this graph, it is expected that the growth of a novel cell concept will grow faster than developing only energy or only power cells.



# Testing: Cell Characterization – Can we fulfil these expectations? Can we validate our model?

- The demanding future of the lithium-ion cell technology necessitates an accurate cell characterization at BoL, MoL and EoL.
- Post-mortem analysis.

| BoL, MoL & EoL Characterization | Abuse |
|---|---|
| DCIR Behavior | Mechanical Abuse |
| Capacity | Electrical Abuse |
| Calendar and cycling aging | Thermal Abuse (Temperature Range) |
| Charge and discharge characteristics | |
| OCV – SOC Behavior | |

# Simulation: Role of Electrochemistry in a Digital World – A tricky player

- Electrochemistry is the basis of lithium-ion cell technology and innovations. The most frequently used (predicated on), accurate and complex electrochemical model is ***Doyle-Fuller-Newman (DFN) Model*** with a total of *88 parameters* based on 5 equations:

1. Electrode Mass Transport Equation
2. Electrolyte Mass Transport Equation
3. Electrode Charge Transport Equation
4. Electrolyte Charge Transport Equation
5. Intercalation Current Density

- These parameters *change constantly* while the battery is in use and during storage. Challenge: complexity!
- There several different approaches for modelling/simulation (electrochemical, electrical… etc.), however they are less detailed than the DFN model.

➢ **Result:** In an electrochemical world it is not very easy to use only digital tools. This electrochemical area of battery design and development may never be 100% suited to digital replication due to its complexity. Testing should always be there to support and validate digital tools. In a good validated simulation one can be confident about safety and stress, however EoL modelling is more difficult to model.

# Thank you for your attention!

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