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# Energy density and the future of EV batteries

Adam Panayi, Managing Director, Rho Motion AMA - European Battery Metals Event 0

#### About Rho Motion



- Rho Motion provides long-term forecasts and analysis of EV battery pack size, chemistry and costs, linking battery pack to EV platform
- Our core monthly and quarterly assessments and outlook provide ongoing analysis of the development of EV battery pack sizes, energy density, chemistry and costs, as well as the rate of growth of the EV market by vehicle class.
- Find out more at <u>www.RhoMotion.com</u>; or contact us direct on:

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#### Our products





- Energy density and its impact on EV range
- Battery chemistry and technology, and its consequences for EVs
- EV platform and battery pack cost developments
- Outlook for EVs and battery demand

# There are around 50 EV markets at present, globally penetration rates are at 2%



BEV & PHEV penetration rates and market size by country, 2018



EV penetration rate % of total PC & LDV market

Source: Rho Motion, vehicle manufacturers, country and regional OEM association data, trade data

# Energy density and EV range

# Battery pack sizes have been rapidly increasing for BEVs from since 2015, they are set to grow further



Source: Rho Motion, vehicle manufacturers

#### Vehicle ranges have, for the most part, been rising with **rho** pack sizes

#### Weighted average range of BEVs sold by year, KM, 2012-2018



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# Battery chemistry and technology



# Higher energy density is a key component in lowering cell costs



Estimated battery cell cost by chemistry, 2018

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# Cell numbers have remained relatively stable, despite larger battery pack capacity



Average number of cells per battery pack in BEVs for vehicles sold 2012-2018



# Silicon is already playing a key role in increasing energy **the motion** density

- At present silicon blending with graphite is on average 4% for automotive applications, at maximum 6%, not 10% as occasionally reported
- Additive is typically silicon oxide rather than pure silicon
- Full silicon could theoretically provide 20% increase in energy density over conventional anode



Volumetric & Gravimetric Energy Density





**EU**CVIX

Source: Enevate

NANOTECHNOLOGIES

#### Why, and why not, solid state?

- Up to 70% higher energy density compared to Li-ion
- Higher voltage Faster charging
- Potential for improved safety
- Still at R&D stage
- Lithium metal is highly reactive
- Cost is an issue Lithium metal and electrolysis
- Supply chain needs to be developed
- Polymers and different electrolyte being explored including Garnet
- Costs and energy density for Lithium ion improving







# EV platform and battery pack cost developments

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# Efficiencies in pack design and management have also **motion** increased capacity



Source: LG Chem

#### Dedicated EV platforms are coming

- VW planning 50 EV models from the same platform
- Aim to offer to variety and cost savings
- May supply other OEMs on the same basis
- 2020, First vehicle to be released on the platform likely to be ID- NEO aiming for the same price as an equivalent diesel
- By 2022, production in 8 different locations
- 2022-23 compact SUV from the platform available at €18,000

#### VW's Modular Electric Drive Construction Kit (MEB)<sup>1</sup>





# Outlook for EV and battery demand

#### Electric Vehicle and Battery Outlook Methodology

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# EV sales penetration rate by vehicle class to 2040, taken from our EV & Battery Quarterly Outlook, Q1 2019





## Conclusions

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- The arrival of NCM 811 will be a key milestone in reducing cell costs and improving energy density
- Developments in pack and platform design are also fundamental to improving vehicle performance
- Solid state technology still has a long way to go before becoming viable
- Ultimately battery capacity will continue to increase as costs fall

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# Any questions?

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