Electric Vehicles – a disruptive force underpinning our commodities

The Electric Vehicle Initiative is a multi-government policy forum targeting 30% market share for electric vehicle sales by 2030.
The energy and mobility transformation currently underway is unlocking material new sources of demand for enabling commodities such as copper, nickel and cobalt.

The emergence of electric vehicles (EVs) is set to transform the mobility space due to a combination of factors:

**Environmental considerations**
Momentum to decarbonise the economy is gathering pace as nations increasingly coordinate efforts on this transition. Bloomberg New Energy Finance forecasts investment in zero carbon energy at c.$8.7 trillion by 2040, with an estimated 530 million electric vehicles on the road.

**Political mandate**
A growing consensus, highlighted by the Paris Accord and the Electric Vehicle Initiative (EVI), is seeking to coordinate national and regional policies towards a low carbon future. Specifically on transportation, the EVI is a multi-government policy forum comprising 16 major global economies. The initiative seeks to facilitate the global deployment of 20 million EVs by 2020. A further campaign announced in 2017, led by China, targets at least 30% new electric vehicle sales by 2030, collectively across all EVI countries.

**Technological progress**
Rapid advances in technology are emerging across the EV supply chain, from power generation and storage to charging and vehicles.

With technological progress comes cost efficiencies, enhanced performance and ultimately products that can compete with traditional internal combustion engine (ICE) alternatives.

Industry commentators now expect the total cost of ownership (TCO) for EVs to reach parity with ICE vehicles in the early part of the next decade1.

**Consumer experience**
While the EV story is clearly in its early days, existing EV models and those under development are already demonstrating performance comparable to, or exceeding, equivalent ICES.

Average EV range, acceleration and speed are increasing while targeted charging times and TCO are rapidly decreasing; all enhancing the consumer experience.

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1 CRU ‘Mobility and Energy Futures – Perspectives towards 2035’ prepared for Glencore by CRU Consulting.
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Driving demand

Rapid technology advances in battery chemistry, along with strong government support, is accelerating the economic breakeven point of electric vehicles and building demand for our key commodities.

Predicted growth in EV sales

<table>
<thead>
<tr>
<th>Year</th>
<th>ICE</th>
<th>Hybrid EV</th>
<th>Battery EV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>94%</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>2025</td>
<td>85%</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>2030</td>
<td>64%</td>
<td>6%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Total cost of ownership – closing the economic gap with conventional vehicles

<table>
<thead>
<tr>
<th>Year</th>
<th>ICE</th>
<th>BEV without subsidy</th>
<th>BEV with subsidy</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>3000</td>
<td>3200</td>
<td>3400</td>
</tr>
<tr>
<td>2025</td>
<td>2800</td>
<td>3000</td>
<td>3200</td>
</tr>
<tr>
<td>2030</td>
<td>2600</td>
<td>2800</td>
<td>3000</td>
</tr>
</tbody>
</table>

Estimated average metal use per vehicle:

- **Copper**: 84kg
- **Nickel**: 50kg
- **Cobalt**: 8kg

Based on estimated 53kWh global average battery pack size.

The impact of this growth in demand for metals has implications across the value chain:

- **Generation and grid infrastructure (kt)**
  - 2020: Cu 40, Ni 20, Co 7
  - 2025: Cu 170, Ni 71, Co 26
  - 2030: Cu 536, Ni 150, Co 55

- **Grid storage (kt)**
  - 2020: Cu 24, Ni 20, Co 7
  - 2025: Cu 86, Ni 71, Co 26
  - 2030: Cu 180, Ni 150, Co 55

- **Charging infrastructure (kt)**
  - 2020: Cu 23, Ni 66, Co 17
  - 2025: Cu 115, Ni 299, Co 80
  - 2030: Cu 392, Ni 985, Co 259

- **Non-ICE vehicles (kt)**
  - 2020: Cu 304, Ni 66, Co 17
  - 2025: Cu 1,068, Ni 299, Co 80
  - 2030: Cu 2,972, Ni 985, Co 259

Leading to additional metal demand by 2030:

- **Copper**: 4.1Mtpa (18% of 2017 global supply)
- **Nickel**: c.1.1Mtpa (55% of 2017 global supply)
- **Cobalt**: 314ktpa (332% of 2017 global supply)
Potential supply
Glencore is well-positioned to supply into the energy and mobility evolution

Our commodities are crucial to the electric vehicle (EV) story
The energy and mobility transformation currently underway is forecast to unlock material new sources of demand for enabling underlying commodities including copper, nickel and cobalt.

We are uniquely positioned with our commodity mix, having strong production growth across these three core EV metals over the next three years.

Glencore own source copper
25% growth in production to 2020

Glencore own source nickel
30% growth in production to 2020

Glencore own source cobalt
133% growth in production to 2020

On the cusp of mainstream EV roll-out
The rate at which automotive and battery companies have scaled up electric vehicle investment plans speaks to our opportunity as a supplier of key metals.

Global automaker investment now totals over $90 billion, with at least $19 billion attributed to the U.S., $21 billion to China and $52 billion to Germany.

Volkswagen alone plans to spend $40 billion by 2030 to build electrified versions of over 300 models. Chinese automakers are ramping up focus on the EV story, while a number have announced investment partnerships with the likes of Ford, VW and General Motors.

Global planned and existing battery cell production capacity amounts to over 300GWh, which compares to Tesla’s Gigafactory target capacity of 35GWh. China accounts for approximately two-thirds of the total.

How much metal is required?
To illustrate the demand potential for a number of our key commodities, we commissioned CRU to model the metal requirements across the supply chain to achieve the EVI target of 30% EV market share by 2030.

Unsurprisingly the forecast metal requirements are significant, as early as 2020.

An additional c.4.1Mt of copper (18% of 2017 supply), c.1.1Mt of nickel (55% of 2017 supply) and 314kt of cobalt (332% of 2017 supply) will be required to enable 30M EV sales by 2030.