INTERNATIONAL COUNCIL OF ACADEMIES OF ENGINEERING AND TECHNOLOGICAL SCIENCES – OCTOBER 2021

Martín Pérez De Solay (I.ENG)

Managing Director & Chief Executive Officer, Orocobre Limited (ASX:ORE)

- Qualified industrial engineer from the Instituto Tecnológico de Buenos Aires and has completed management programmes at the Kennedy School of Government, Harvard University and Austral University.
- Career spanning engineering, operational improvement, banking, finance and executive management.
- Appointed as CEO & MD at Orocobre Limited in January 2019.
- Prior roles: President and CEO of Petróleos Sudamericanos, an oil and gas producer operating in Argentina, Colombia and Ecuador and CFO and Head of Corporate Development of GeoPark.

- Orocobre is a dynamic global lithium chemicals supplier and an established producer of borates.
- In partnership with Toyota Tsusho Corporation (TTC), Orocobre has built and is now operating the world's first commercial, brine-based lithium operation in the last 20 years.
- Orocobre is dual listed on the Australian Securities Exchange (ASX:ORE), the Toronto Stock Exchange (TSX:ORL) and is included in the S&P/ASX 200 Index.
- In 2018 Orocobre announced the Stage 2 Expansion of its flagship Olaroz Lithium Facility in Argentina, taking full production and capacity to 42,500 tpa of lithium carbonate for sale to industrial, technical and battery markets
- Additionally, Orocobre and TTC have commenced construction of a 10,000 tpa lithium hydroxide plant in Naraha, Japan. This new hydroxide plant will be the first of its kind in Japan and will provide Orocobre product diversification suitable for different battery technologies.
- On April 19, 2021, Orocobre Limited and Galaxy Resources Limited announced that they have entered into a U$S4bn binding Merger Implementation Deed under which the two companies will merge via a Galaxy Scheme of Arrangement pursuant to which Orocobre will acquire 100% of the shares in Galaxy.

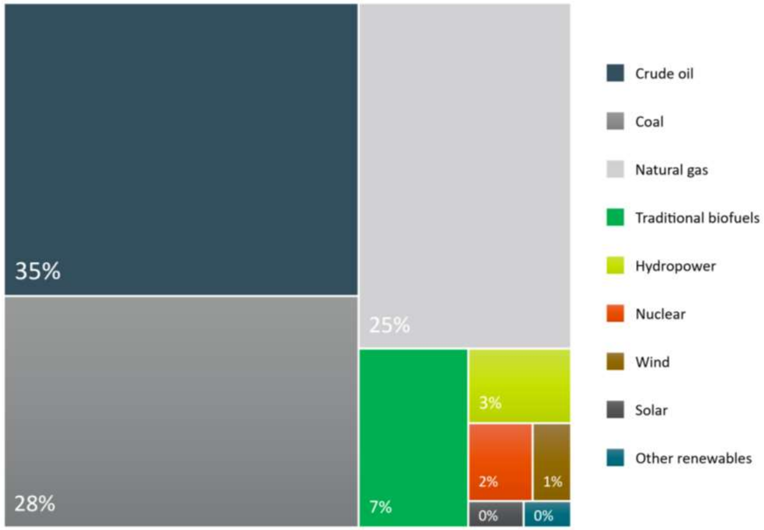
ENERGY TRANSITION – WHERE WE ARE AND WHERE ARE WE GOING?

Renewables, electrification and energy efficiency are the main pillars of the energy transition

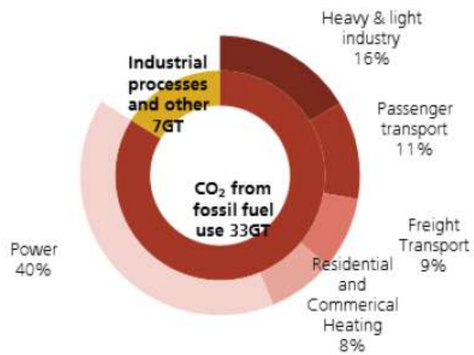
In 2020, petroleum, natural gas and coal account for ~85% of the total energy consumption being the cheapest, most effective and reliable sources of energy. Environmental concerns have gained momentum.

The energy transition will combine the use of low-cost renewable power and the wider adoption of electricity in transport and heat.

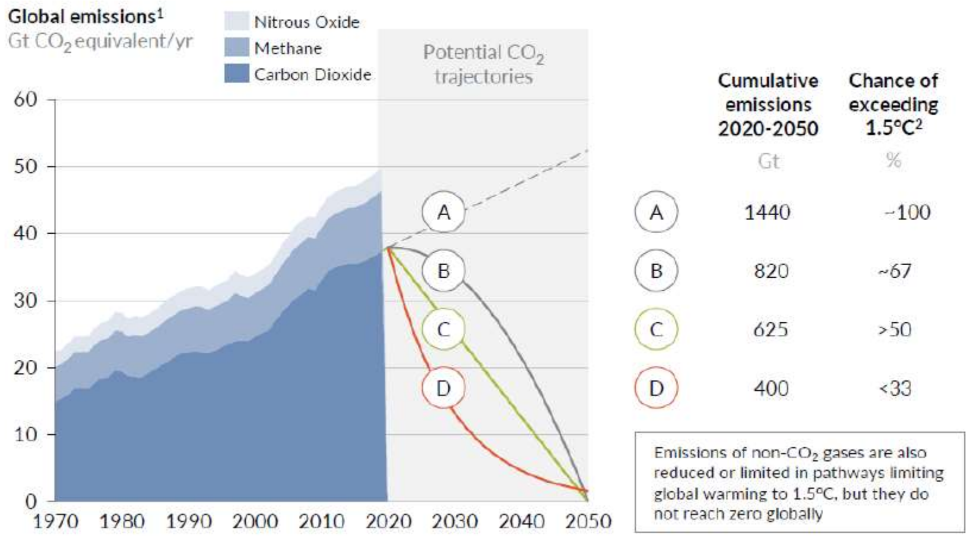
160,358 TWh **Total Final Energy Consumption 2020**



2019 Global CO_2 emissions by sector, total 40 GT, 2019



McKinsey & Co's preliminary projection estimates peak demand for fossil-fuels by 2027



To achieve net zero emissions by 2050, clean fuels will have to increase from **current 15% of total energy consumption to >55%.** By 2030 **annual production of electric vehicles needs to be ten times higher than it was last year, the number of roadside charging stations 31 times bigger, the installed base of renewable-power generation needs to rise three-fold,** global mining firms may have to raise the annual production of critical minerals by 500%. Perhaps 2% of America's land will have to be blanketed in turbines and solar panels.

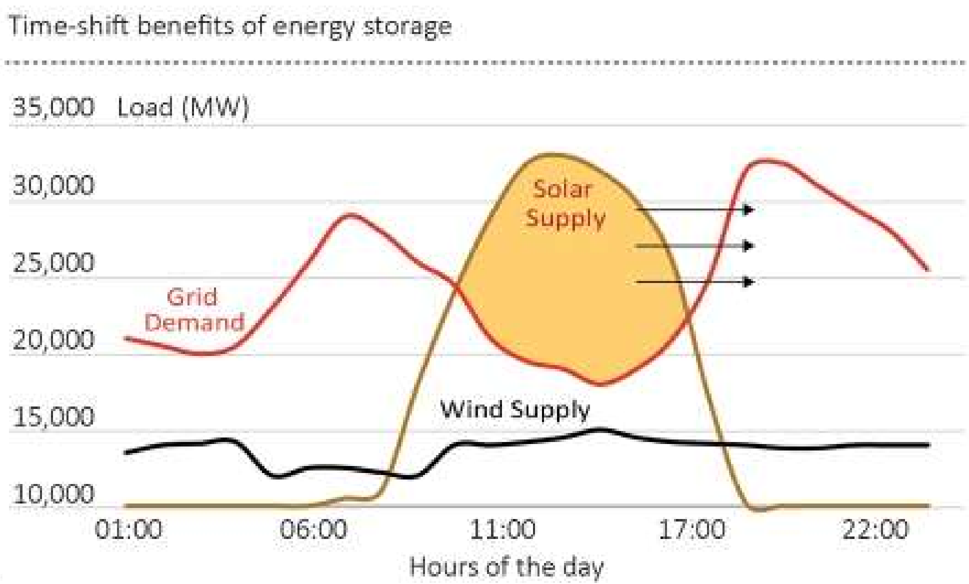
Decarbonizing the energy system alone will require around **$120T to $160T of cumulative investments to 2050**. Upgrading infrastructure and increasing carbon dioxide removal could require additional investment. **Fossil fuel investment will have to decline.**

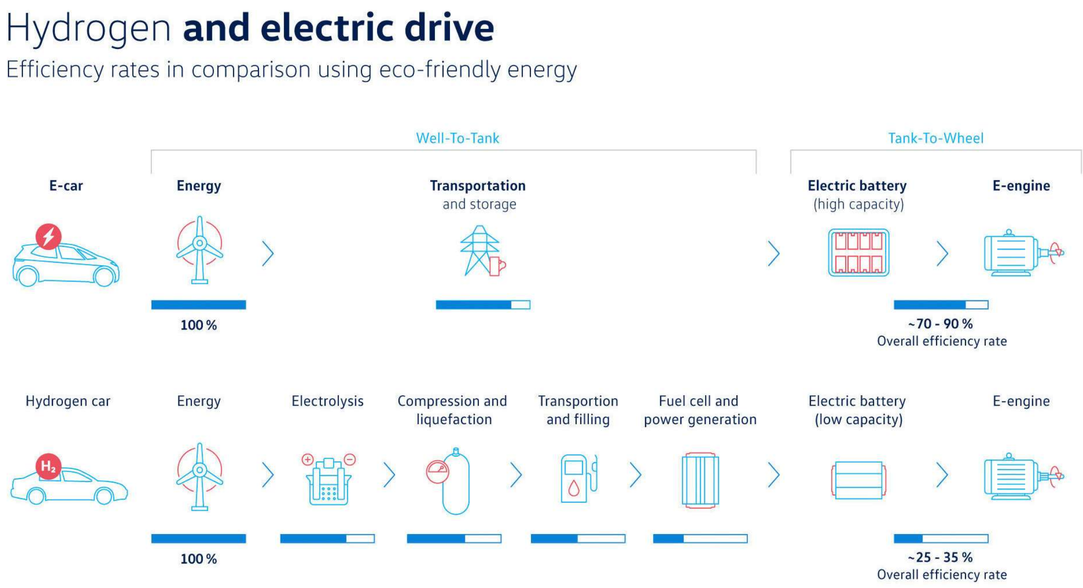
**Source: UBS, McKinsey & Co, The Economist, IRENA*

WHAT WE NEED FOR THE ENERGY TRANSITION?

The transition will depend on alternative energy storage rather than relying on fossil-fuels

Intermittent renewable sources may require backup generation capacity supplied by storable energy sources, installations widely distributed, and a range of different intermittent energy sources that could reduce fossil-fuels





Stationary Energy Storage (SES) with batteries: Electric lithium-ion batteries can be integrated into "stationary" energy storage systems to store green energy to buffer generation and consumption.

Vehicle-to-grid (V2G) technology: Developing "vehicle-to-grid" technology means they can be used while still installed in the electric network to supply their stored energy back to the electricity grid when needed.

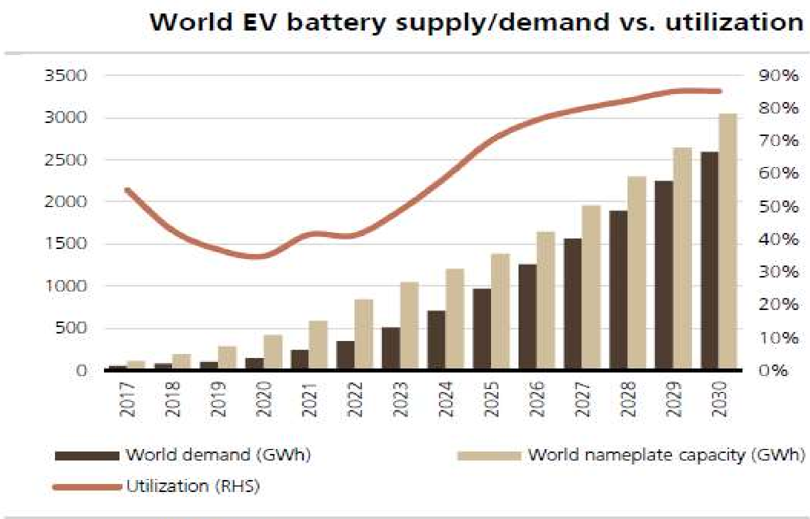
Hydrogen: Hydrogen Council's latest 1.5°C scenario indicates a **18% hydrogen share** of total final energy consumption by 2050. Integrating hydrogen with offshore wind could be a means of carrying clean energy produced offshore to onshore via pipelines and storing hydrogen seasonally can help utilize and manage the seasonal availability of renewable power. Fuel-cell cars have pointed out advantages, including quick refueling times and long range, although only **25% to 35%** of energy makes it to the wheels because of the immense amount of energy needed to produce hydrogen through electrolysis.

**Source: QIC and Volkswagen*

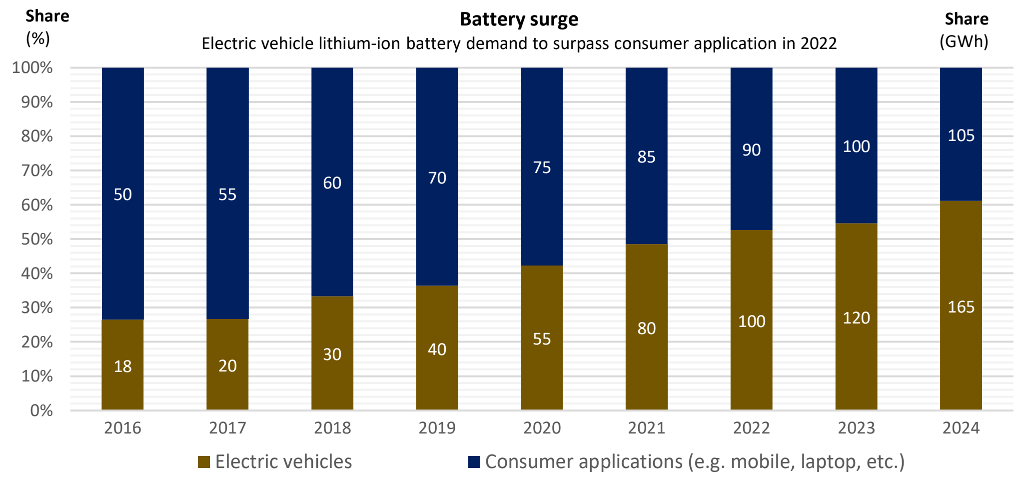
WILL EVS BE A KEY PART OF THE ENERGY TRANSITION?

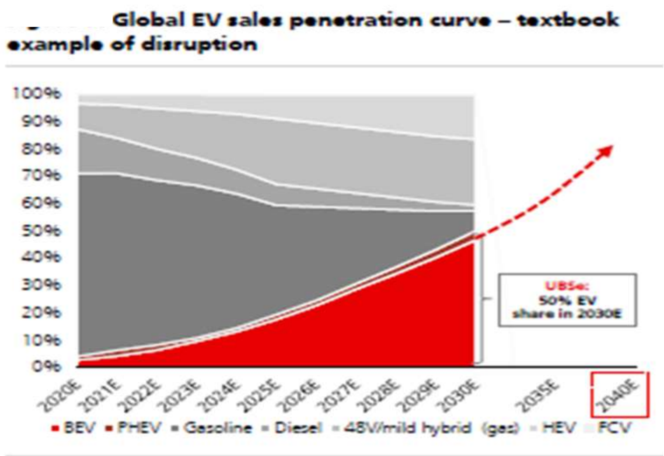
Lithium-ion battery demand will grow to 2,600GWh by 2030 from 148GWh today mainly by Electric Vehicles

Battery-electric vehicles popularity is outpacing estimations driven by increasing global focus on decarbonization, lower battery costs and incentivized by government efforts across the value chain

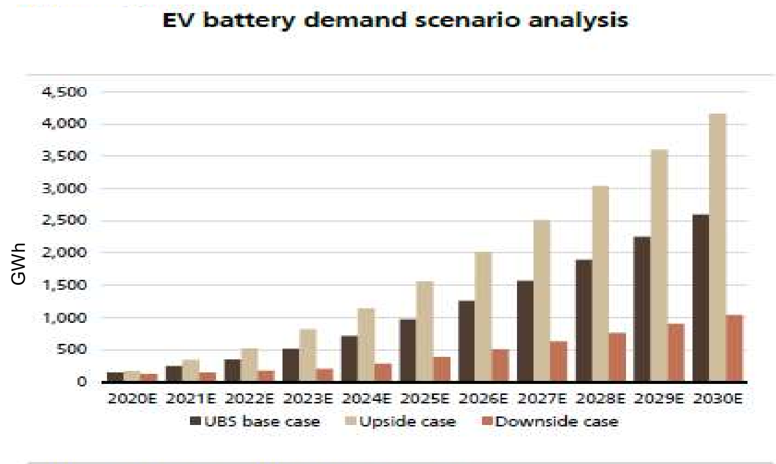


Source: Company data, UBSe





Source: UBS estimates



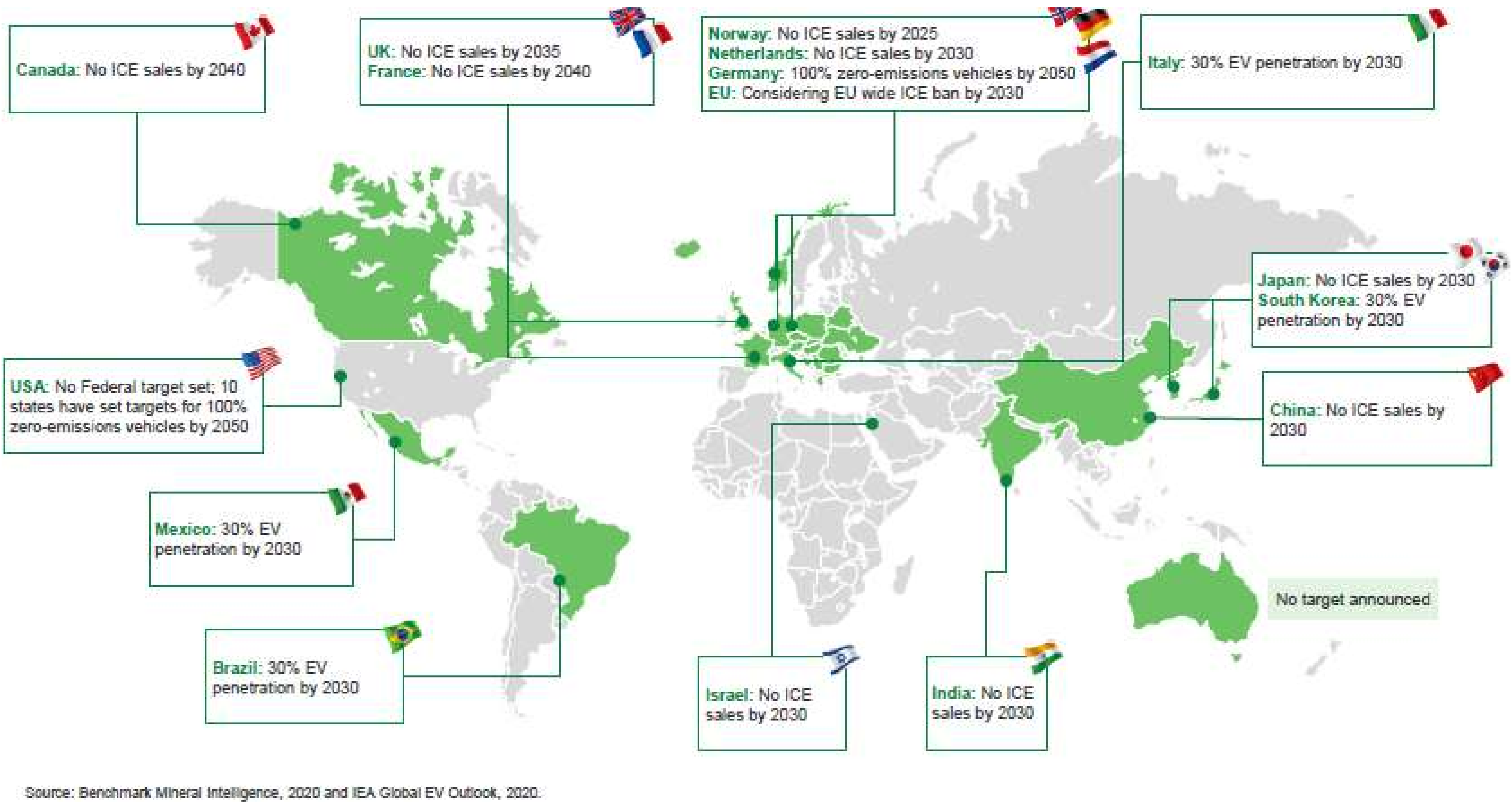
Source: P3 automotive GmbH, UBS Evidence Lab

Source: UBS estimates.

HOW WILL THE TRANSITION TO ELECTRIC VEHICLES WILL OCCUR?

Governments globally are largely aligned with promoting Electric Vehicles mass adoption with a number targeting a complete phase out of Internal Combustion Engine sales

EV penetration rates accelerating from their levels in 2015 despite COVID-19 impacts



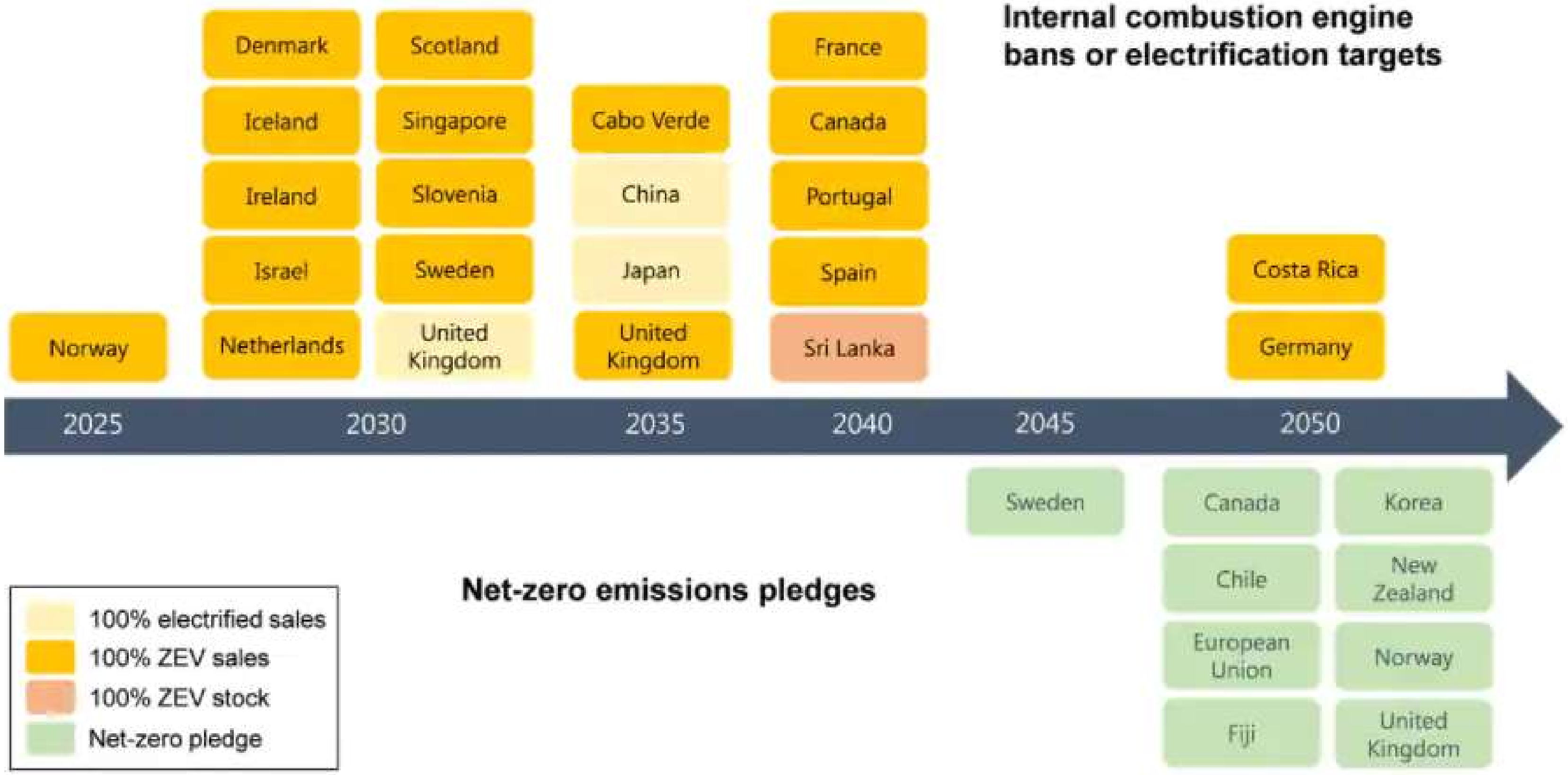
*Source: Benchmark Minerals

ARE WE ENTERING THE ERA OF THE ELECTRIC VEHICLE?

230 million EVs need to be on the world's roads by 2030 to accomplish the interim Paris emissions target on a path to net zero by 2050

Regulations, national incentives, and new sustainability mandates could be the main drivers for EVs adoption

Global Electric Vehicle sales grew +41% in 2020 to about 3 million electric cars, more growth coming through the decade, although reaching 145 million EVs globally by 2030 would be a remarkable feat, it could be insufficient for meeting global emissions targets for 2050

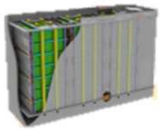


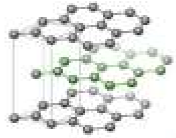
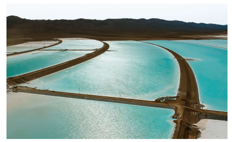
**ZEV: Zero emission vehicle*

**Source: IHS Markit*

HOW EV DEMAND TRANSLATES TO BATTERY MATERIALS?

EVs account for 40% of lithium demand and will become 70% of total lithium consumption

Unit	Electric Vehicles *EV cars sold (million cars)*	Electric Vehicles *% penetration (Evs/cars sold)*		Battery Pack *GWh*	Cells *kWh per vehicle*		Battery Materials *Cathode and Electrolyte chemistry Li g/ kWh*	Lithium Carbonate Equivalent *LCE tns*
2025	15.5 m cars	17.4%	*Consensus 15%*	973 GWh	62 kWh/car	*MS: 50 kWh*	Cathode: 615 g/Kwh Electrolyte 100 g/Kwh	600 - 700 ktns LCE
	CAGR: 33%							
2030	35.5 m cars	39.7%	*MS 31%*	2,596 GWh	73 kWh/car	*MS: 48 kWh*	Cathode: 750 g/Kwh Electrolyte 100 g/Kwh	2,200 ktns LCE *CAGR: 30%*
2022 Cost	Cost gap 1,900 $ per car ICE vs BEV			Battery pack < 100 USD/kWh			All cathode chemistries have 11% lithium	Cathodes represents ~80% of the cost of the Battery Pack. The Battery Materials represent 60% of the cell cost

- Industry battery system costs overtook previous estimates by **$20/kWh** and should reach **$100/kWh** by 2022.
- $20/kWh is equivalent to $1,000 – $1,500 savings per car. Total cost gap with conventional cars is merely $1.9k in 2022, and should be fully close by 2024.
- Taking subsidies, lower cost of ownership etc into account, the EV will be the preferred choice for consumers from a purely financial perspective in many car markets.
- UBS 2030 ~40% EV penetration translated into material demand will bring about an exponential lift in demand for some commodities (i.e. 7x lift in total Lithium demand from 300kt in 20e to ~2.2Mt in 2030e).
- Consensus modelling for EV penetration is 10-15% by 2025E vs. UBS at 17%.
- LFP cathode technology was dominant in China and has seen little to no use in overseas market. Subsidy changes encouraging the use of longer-range NCM batteries caused a phasing out of LFP. In just 3-4 years LFP's share of the China market went from **70% to below 30%.**

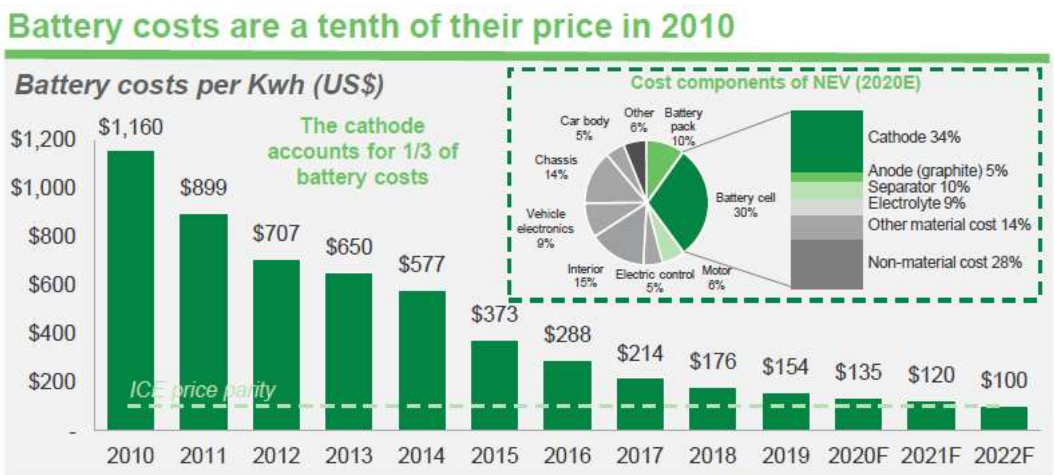
**Source: estimated, based on UBS and Morgan Stanley [MS]*

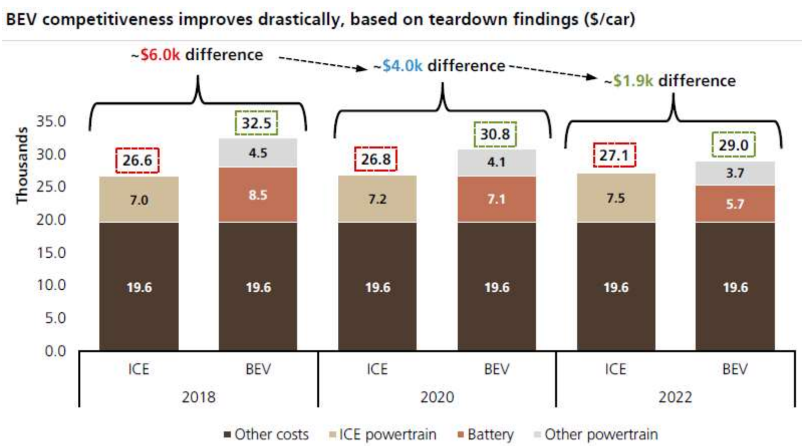
WHAT IS THE COMPOSITION OF THE BATTERY MARKET?

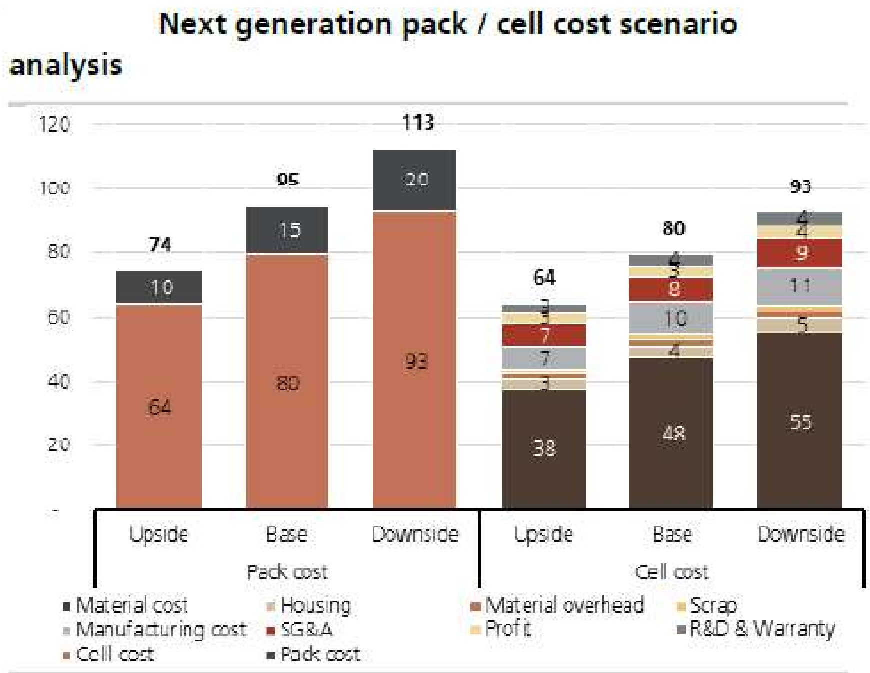
The battery market has evolved exponentially in the last 10 years, and it's expected to continue increasing by 13-fold in the next 10 years driving step changes in demand for the raw materials

First Li-ion batteries appeared in Japan in the 90's; 20 years later, they are of common use in every smartphone

Experts believe the target cost for batteries will be below $100/KWh, upside projections get to levels of ~$50/KWh or less







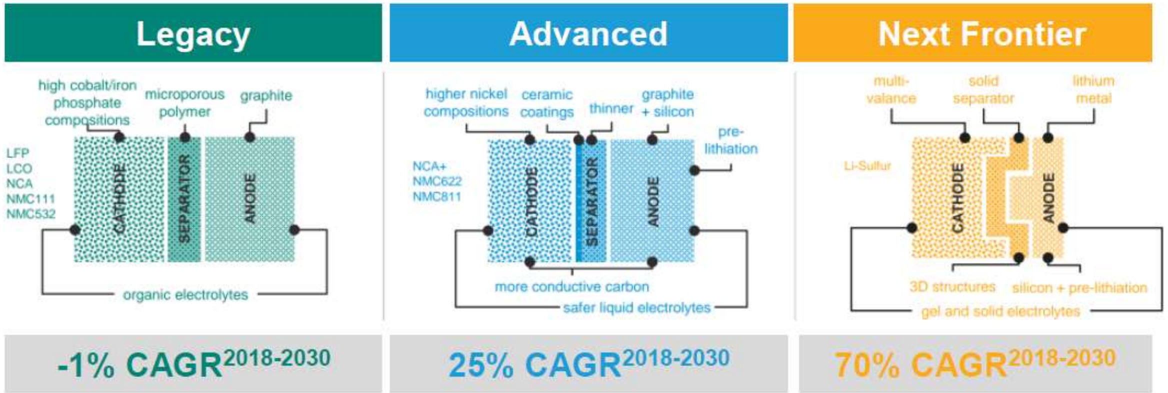
Source: P3 automotive GmbH, UBS Evidence Lab

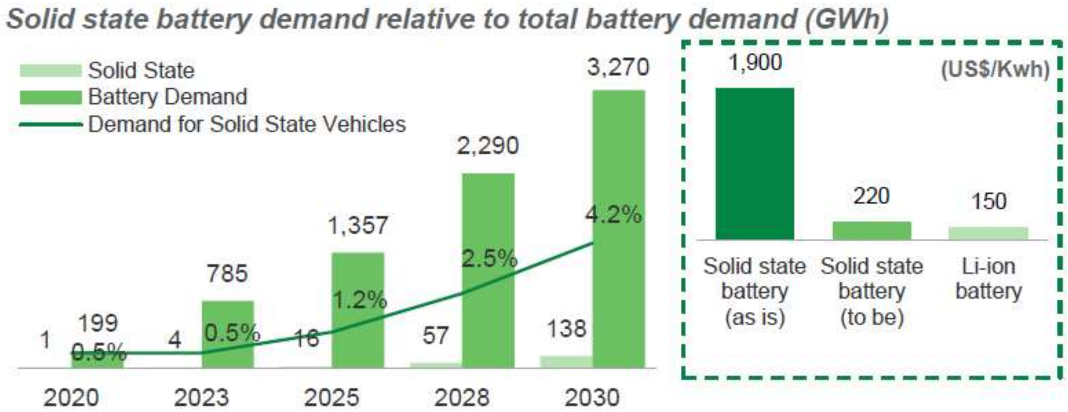
**Source: UBS, Macquarie estimates.*

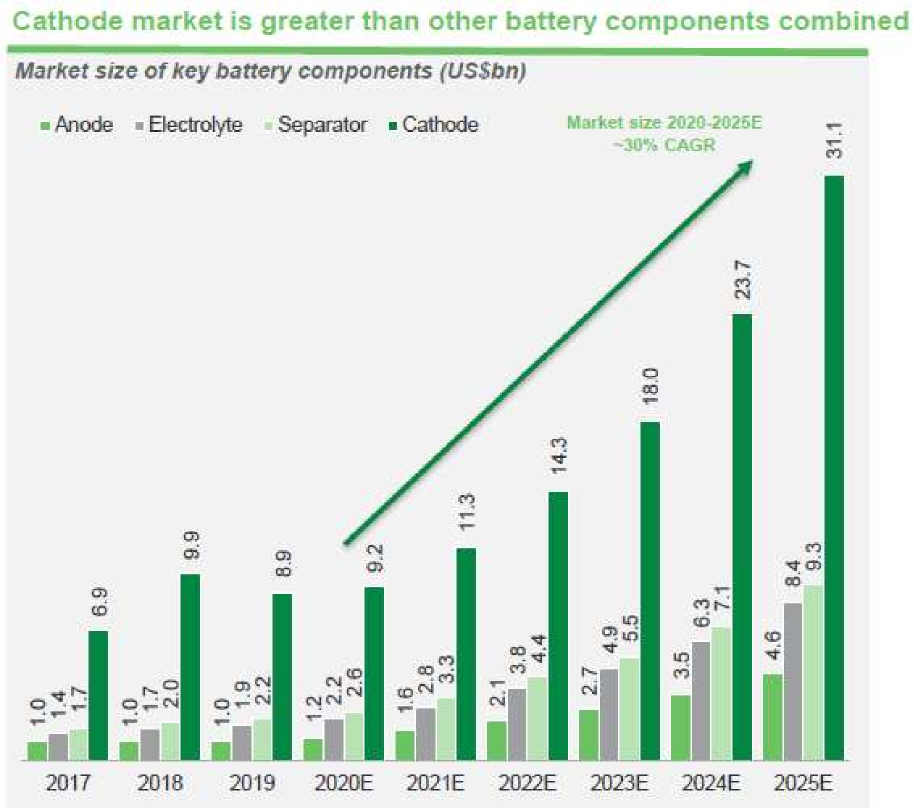
BATTERY TECHNOLOGY IS EVOLVING QUICKLY

Technology progression could see lithium usage increase

Solid-state batteries could represent the next frontier by improving safety standards and power capacities with lithium metal anode potentially replacing graphite







*Source: UBS, Macquarie estimates.

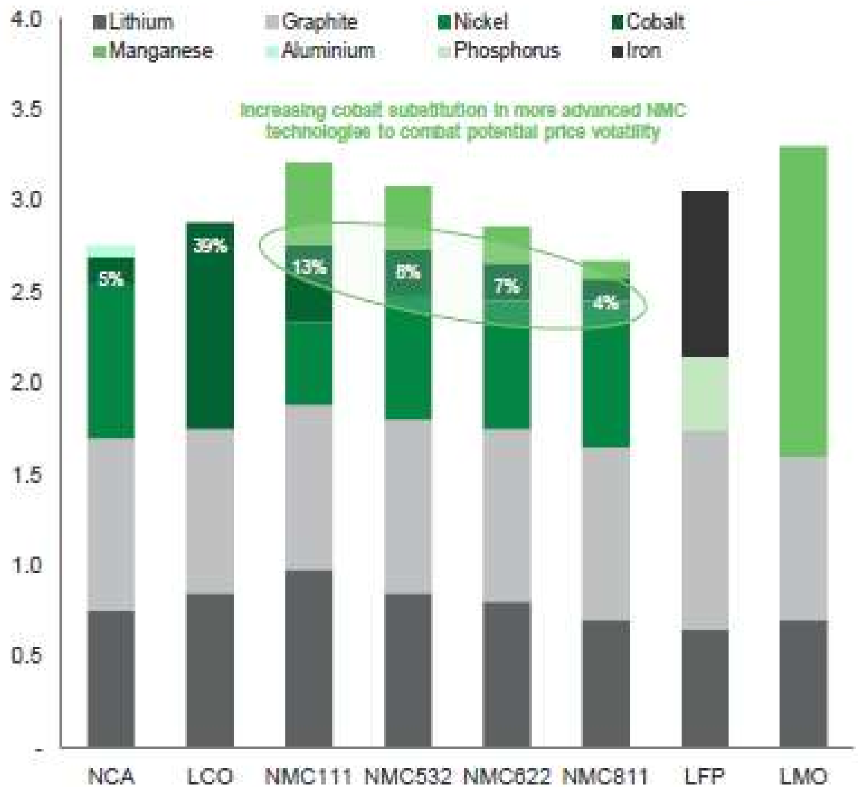
HOW DO RAW MATERIALS BENEFIT FROM THE ENERGY TRANSITION?

Lithium has the highest charge-to-weight ratio desired for transportation applications making it the battery metal least likely to be replaced by substitution

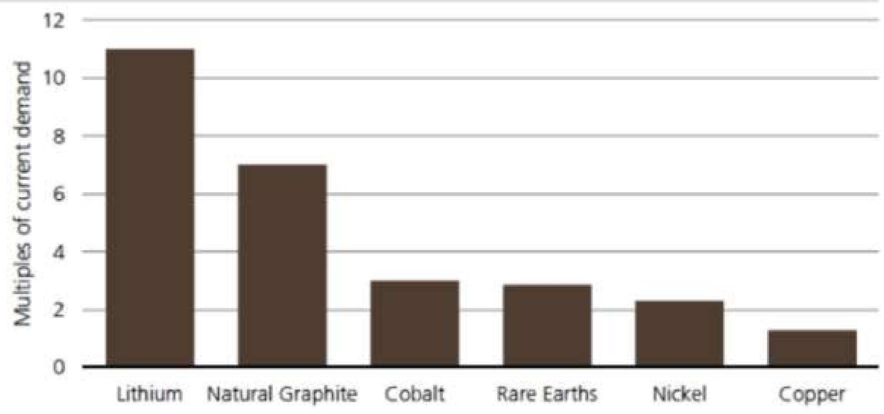
Battery metals include lithium, cobalt, manganese, nickel and phosphorus, among others. The rapid rise in raw material demand sees deficits forming over the next decade.

Lithium content stable in battery chemistries, thrift for cobalt

Elemental content of cathode materials (excluding oxygen), kg/kWh



Demand growth through to 2030e



Source: UBSe.

2030 market balance projections

Commodity	Deficit Emerges	Size of Deficit in 2030e	Deficit as % of Market
Cobalt	2023	68kt	23%
Copper	2024	9.6Mt	30%
Lithium	2028	878kt	34%
Natural Graphite	2027	1.6Mt	43%
Nickel	2020	1,023kt	21%
Rare Earths	2023	41.1kt	47%

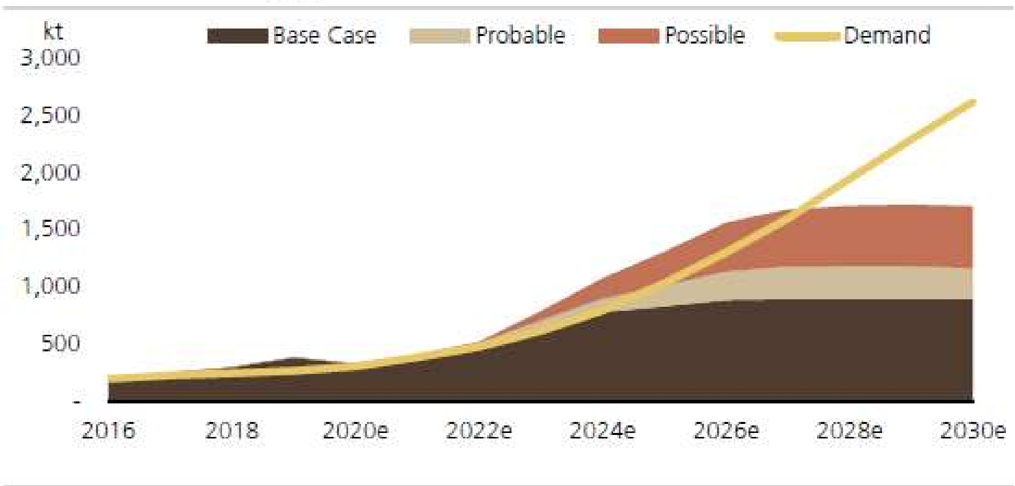
Source: WoodMac, UBSe

**Source: UBS, Macquarie estimates.*

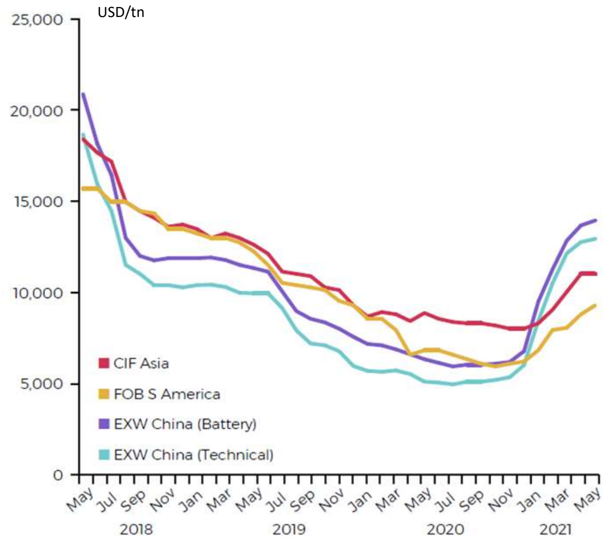
WHAT IS THE OUTLOOK FOR THE MAIN RAW MATERIALS?

Commodity prices are rising as market sees a shortfall in production and investment incentivizing new supply

Lithium Supply-Demand Balance



Source: Wood Mackenzie, Company Filings, UBSe.



- **Lithium:** Lithium is a pre-requisite for all current and emerging battery technologies thus EV demand is not at risk from how the cathode evolution evolves. This contrasts with cobalt, which battery makers are trying to shift away from. **Lithium is mainly used as a precursor to cathode materials and is ingested as a chemical compound** – as either lithium carbonate or lithium hydroxide. Brine production has a competitive advantage in lithium carbonate output, but an additional step (and cost at around ~US$1,000-US$1,500/t) is required for hydroxide production, which puts it behind spodumene producers who can convert directly to hydroxide. Hydroxide demand works better in cathodes where the content of the cathode is ≥ 60% nickel and base case battery forecast assumes a migration towards higher nickel formats. **LT prices (nominal 2025) CIF Asia: Spodumene 620 $/t** (+43% c.price), **Lithium carbonate 11,771 $/t (+54% c.price), Lithium hydroxide 13,452 $/t** (+40% c.price).

- **Graphite: The future of natural graphite is subject of conjecture with two competing materials: synthetic graphite and silicon**. Synthetic graphite appears to be preferred to natural graphite when comparing performance alone in the battery but is significantly more expensive. The introduction of silicon into the anode is continuing to gain traction and will provide incremental performance gains to the battery. **LT prices (nominal 2025) FOB: Graphite flake +80 mesh 1,065 $/t** (+51% c.price).

- **Copper:** Each EV represents **~95kg** of copper demand or **~75kg** of incremental demand compared to ICE vehicles. Copper demand from EV is likely to carry less risk than that of other commodities because there are major debates in other commodities about battery assemblage, but copper is critical in transferring power within an electric vehicle. The nearest substitute is aluminum, which has displaced copper demand in transmission and distribution, but not likely to displace copper from this role due to the space and weight advantages copper affords. However, **demand is set to explode, but years of under-investment threaten to leave supply short. LT prices (nominal 2025): Copper 3.4 $/lb** (+23% c.price).

- **Nickel: Nickel is favorably exposed to demand from electric vehicles due to many battery technologies with nickel in the cathode** and the movement toward using more nickel and less cobalt in these. The 3 dominant cathode chemistry's for electric vehicles are Lithium-Iron-Phosphate (LFP), Nickel-Manganese-Cobalt (NMC) and Nickel-Cobalt-Aluminum (NCA). High performance batteries require high grade nickel feed-stocks, in short Class 1 nickel products, as opposed to current grade leading to a **large capital commitment in the order of $2-5bn for 20-40ktpa of capacity to increase purity**. **LT prices (nominal 2025): Nickel 6.7 $/lb** (+10% c.price).

**Source: UBS, Benchmark Minerals*

ARE WE ENTERING A COMMODITY SUPERCYCLE?

Energy Transition, ESG policy and private investment could be drivers for next supercycle

Weaker greenback, supportive Central Bank policy and government spending on post pandemic recovery fuel inflationary expectations.

Green bottlenecks threaten the clean energy business so there is a crucial role for an activist state by easing planning rules and help companies and investors deal with risks. The average global mining project takes 16 years to get approval; the typical wind project in America over a decade to get lease approvals and permits, thus its offshore-wind capacity is less than 1% of Europe's. Governments can provide certainty in guaranteeing minimum prices for power generation and by introducing carbon prices which give investors more visibility over a long-term horizon. **Today only 22% of the world's greenhouse-gas emissions are covered by pricing schemes, and those schemes are not joined up**.

Supply-side issues

- Grade decline and mine closures are an ongoing feature of the copper industry
- Oil: short cycle vs. long payback oil projects, and problem of social license to operate
- Higher prices don't always translate into license to expand
- Rising cost of capital for oil majors: Scope 1 and 2 emissions reduction is insurance policy against expensive debt

Demand drivers

- Due to policy statements and public opinion trends, major automakers have committed over U$S300bn towards developing battery EV
- Green capex: Stimulus geared toward green job creation
- Unlike 08'-09' crisis, stimulus packages support lower middle class, supporting consumption levels
- **The overwhelming priority must be to catalyse a bigger surge in private investment for clean energy business**

**Source: Benchmark Minerals, Trading Economic, The Economist*

WHAT PARTS DOES THE EV BATTERY SUPPLY CHAIN NEED TO ADDRESS?

It takes much longer to build a lithium project than a battery plant creating higher exposure on price volatility and market trends

Current

Current Supply Chains for Europe and North America focus on global mining and Asian refining of cathode materials

Huge pressure to build out European and North American Supply Chain to reduce costs and create jobs

Future

Growth of battery supply chains allows future sourcing to optimized, reducing shipping and working capital, while reducing political risk

	Extraction	Chemical Processing	Cathode/Anode Production	Cell Manufacturing	Application
	Li Co C Ni		+ Cathodes — Anodes		
Strengths	High IRR Potential for super profits Large employment numbers	Short lead time Low Capex Price certainty	High-value products Require specialized high-paying skills Price certainty Moderately attractive IRR	Short lead time Require specialized high-paying skills High economic value multiplier	Short lead time Price certainty High economic value multiplier
Challenges	High Capex Long lead times Geological constraints High risk of capex overrun Volatile pricing	Low IRR	High Capex High risk of capex overrun High intellectual property barrier	Constant price pressure Low IRR High CAPEX	Low IRR Margins constantly under pressure Well-establish global hubs with recognized brands
Typical Project IRR	15-40%	10-15%	15-25%	10-20%	5-15%
Years to production	5-25 years	1-3 years	2-3 years	2-5 years	4-7 years
Capex[1]	$1-2bn	$150-300m	$300-450m	$1-2bn	$0.5-4bn

**Source: Benchmark Minerals*

WHAT IS SOUTH AMERICA’S ROLE IN THE ENERGY TRANSITION?

Region’s resources is partly due to the vast salt flats, where lithium is extracted from brine ponds through an evaporation process facilitated by the solar radiation

Total lithium resources identified around the globe total 86 million tons as of 2020, a 39% increase from resources identified in 2018 meaning lithium is not a rare element but its economic viability is challenging

Argentina has the world’s second-largest lithium reserves, totaling around 17 million tones.

Argentina and the region has an enormous potential to play a key role in tomorrow’s global energy environment

There are two large mines currently in operation in Argentina: Salar Olaroz in Jujuy Province and Salar del Hombre Muerto in Catamarca Province. **The Salar de Olaroz operations holds more than 12 million tons of resources enough to produce lithium-ion batteries for around 350 million electric vehicles.**

**Source: Americas Society Council of the Americas, Virgen del Valle Litio*

OROCOBRE'S ENVIRONMENT, SOCIAL & GOVERNANCE PRACTICES

Our long-term commitment to sustainability and transparent reporting is evident in recognition from ACSI* and inclusion in the DJSI**

Safe and Sustainable Operations

Orocobre sets clear safety, environmental and social objectives and fosters a culture of collaboration to drive efficiency, quality, and sustainable development at our operations.

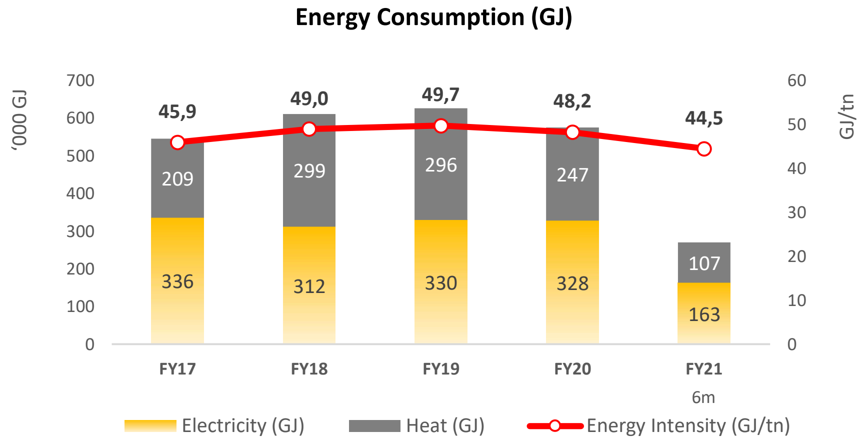
Thriving Communities

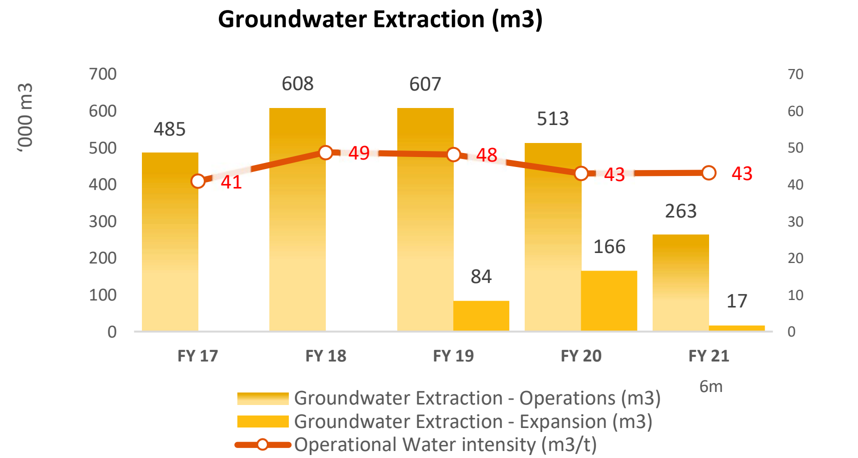
In FY20 we achieved a **2.5% reduction** in Carbon emissions intensity for operations and **10.7% reduction** in water intensity for the Olaroz Lithium Facility, we employed over **620 people** from our local communities.

We stay on track to achieve **zero emissions** by 2030.

Responsible Products

Orocobre services a wide range of customers in an extensive value chain. However, the primary focus of our growth activity is the development of lithium chemicals to fuel the **global transition to a low-carbon economy**.





*ACSI: Australian Council of Superannuation Investors
**DJSI: Dow Jones Sustainability™ Australia Index