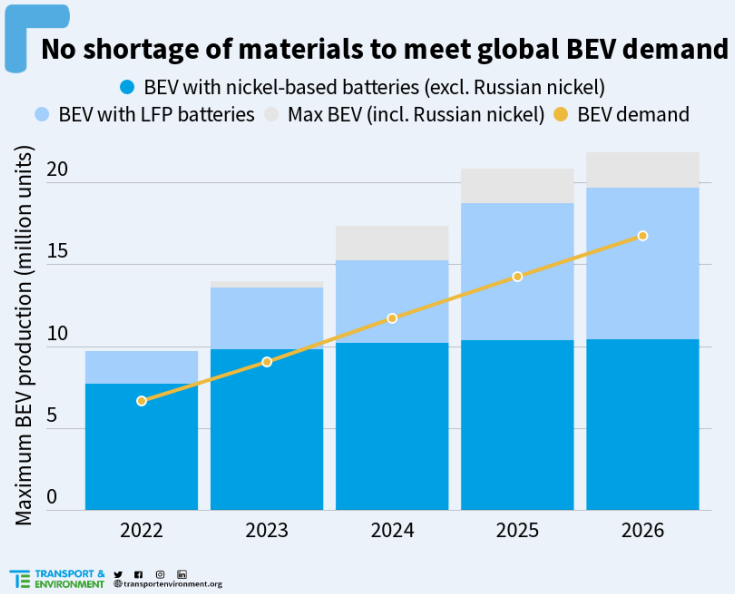
Why Europe can secure enough critical raw materials

Wrong priorities, not metal shortages, are blocking Europe's oil-free future

May 2022

Summary

As the world looks in horror at Russia's war in Ukraine, European governments are finally looking at ways to stop subsidising the war via energy imports. Europe's dependence on Russian oil puts $285 million a day in Putin's pocket - two thirds of this is used in transport. The best structural solution to wean transport off oil is to electrify. So rapid electrification of cars, vans and trucks should be an obvious decision, yet the sales are stalling in early 2022 as no stricter targets are foreseen until 2025. Some claim there are not enough raw materials to build batteries for all those electric vehicles in the short term. In this paper, T&E looks at the availability of battery grade lithium and nickel, two critical metals indispensable to accelerate electrification. Is there enough of these metals globally to speed up the switch to electric by 2025? And will those metals be available on the European market?



The analysis is based on the data derived from BloombergNEF on the global max volumes[1] of Class 1 nickel, lithium hydroxide and lithium carbonate, as well as the max capacity of the battery factories globally up to 2025 (excluding other non-EV uses).

The results show that up to 14 million battery electric cars (BEV) can already be produced globally next year, which is 55% higher than the current market estimates (but there is more gigafactory capacity than raw

[1] Maximum nameplate capacity removing demand from other applications but not accounting for potential financial and technical risks, or unexpected events, such as Covid related factory closures.

materials available to produce even more than this). By 2025, even if the market gets a bit tighter, 21 million BEV can be produced, almost half more than the market estimates. This shows there is enough raw material available short term to switch from oil cars faster. The current supply of battery electric cars is not constrained by the raw materials - the amount of electric cars sold depends on the global car regulations (e.g. ZEV mandates in the US and Cars CO2 in Europe). If Europe has half of all its car sales BEV in 2025, this would require around a quarter of the global BEV production, similar to the share in 2021 and hence feasible.

Even if sufficient lithium and nickel is available short-term, it does not mean European companies can buy them easily. Mining companies, after years of low returns, might be enjoying the high prices on the spot markets and might be unwilling to increase the metal volumes available for purchase too quickly. Rapidly growing electric cars sales in China and the US also mean there is competition for Europe to secure sufficient volumes for its market. China and its companies are in a race to secure global lithium mining assets and expand battery production at home and abroad. The US government has invoked the Defence Production Act to boost domestic supply of critical metals.

In contrast, the EU is focusing its efforts on oil and gas, flying to countries such as Qatar and pooling resources for joint purchasing of fossil gas. Europe should instead use its diplomatic muscle to secure metals for (green) energy independence. Trade relations and diplomacy should be used immediately to secure lithium from resource-rich Australia (where there is some spare capacity) and South America, and nickel from countries like Indonesia and Canada. They can also work with global mining companies such as BHP, Anglo American or Albemarle to ensure max volumes are freely available on the global spot markets (or deploy joint purchasing as a last resort). Going forward, a centralised authority to coordinate the security of supply in critical metals should be created, either under the aegis of the European Battery Alliance or directly within the Commission.

The current high spot prices for lithium and nickel are a legitimate concern. Years of underinvestment, long project lead times and a sudden growth in EV sales to meet regulations have all resulted in the tight metals market. But because there is no shortage of metals in earth's crust these concerns are temporary, just like the 2008 worries about the price of silicon used in solar PV, or the worries about shortage of oil two centuries ago. Ultimately, innovation, diplomatic efforts, an end to Covid, and, more recently, to war disruptions, are expected to stabilise the prices in the next few years.

In the mid- to long-term, many more options are available to Europe. The current high prices are pushing miners and recyclers to increase the supply of battery metals, with a lot of new capacity coming from 2025. Some domestic projects, including cleaner direct lithium extraction and mining from waste, are coming to Europe. Industry is also adjusting to high prices with innovation and substitution, including cobalt and nickel free lithium-ion batteries (LFP) and solid-state technology. Rightly-sized and efficient (often shared) electric vehicles are also a big part of the answer. Ultimately, carmakers should move to secure the supply of raw materials *now* - via direct contracts

or partnerships - for their EV plans in the late 2020s. The bottom line is that the shortage of critical metals is not the problem, but a shortage of political will and industry's preparedness.

Looking into the future Europeans are right to be concerned that Chinese companies control large parts of the battery supply chain. But Chinese dominance is not inevitable. As the metals, battery and EV industry grows, Europe can still secure large parts of it: a third of global battery cell manufacturing is expected to be in Europe by 2030. Even if we continue importing significant volumes of raw materials in the coming decades, we will do so from countries like Australia, Canada, Chile and Indonesia as opposed to Saudi Arabia, Russia, Iran and Qatar.

Going big on sustainability - by beefing up environmental safeguards around mining and demanding spotless social and community engagement record - will help European companies compete. Vibrant global markets centred around sustainability are also key. At home, smart industrial policy (e.g. for domestic refining projects), an unequivocal all-in attitude by the European auto industry (not diverting to non-existent synthetic fuels), and a clear political direction - such as cementing the goal for 100% electric cars and vans from 2035, followed by most trucks - can all put Europe in the race. Searching the world for fossil fuels will not.

Introduction

As the world looks in horror at Russia's continued war in Ukraine, European governments continue to send money to the Russian government for oil and gas imports, directly subsidising Putin's aggression. In fact, Europe's dependence on Russian oil puts $285 million a day in Putin's pocket according to T&E's recent study.

But more and more voices including many governments are now calling for this to stop. The European Commission is tasked to prepare a strategy to reduce Europe's reliance on Russian imports of gas, oil and coal by 2027. This has spurred a raft of diplomacy to secure oil and gas supplies elsewhere, including deals with the US and Qatar to increase gas imports.

Historically, the biggest source of funding for Russia has been its oil exports. Russia currently supplies 25% of Europe's oil, two thirds of which is used in transport. If not Russia, Europe will be reliant on autocratic regimes like Saudi Arabia or Iran unless we drastically cut our oil consumption. When it comes to road transport, the best structural solution is to move to technology that consumes zero oil: battery electric vehicles (BEV). 1 in 10 cars bought across Europe last year were already fully electric, experiencing a 6-fold growth since 2019 thanks to the 2020/21 EU clean car rules ("Car CO2 regulation") that require carmakers to reduce CO2 emissions from their fleet and therefore produce and sell electric cars.

Rapid electrification in the 2020s is key to reduce Europe's dependency on Russian oil by 2027. But the concern is often raised as to the availability of critical metals such as nickel and lithium that are necessary to produce electric car batteries. Some believe ramping up electrification faster in the 2020s is not possible due to the current supply chain disruptions and raw material price spikes.

Are there enough raw materials to accelerate the production this decade? Will they be available to European companies and consumers, and at what cost? This short paper looks at how many electric cars can be produced given the maximum global supply of battery-grade lithium and nickel available in the short term, and what Europe needs to do to secure them. It includes a short section looking beyond 2025, but a more in-depth analysis of this will be coming in the future.

1. How many raw materials are available by 2025?

1.1 Adjusting production within the current supply chains

Currently, following the post-Covid supply chain disruptions and Russia's invasion of Ukraine, most supply chains are impacted and many key metals are rising in cost, including for both internal combustion engine (ICE) and electric cars (EV). Alongside most of the battery grade nickel needed for EV batteries, 40% of global palladium and 10% of global platinum production is in Russia. These metals are critical for emission control systems for diesel and petrol vehicles and if supplies are embargoed or reduced due to payment problems, this will be very problematic for carmakers producing ICE. Equally, all car sales are down currently, expected to be a short term situation.

Similar issues are seen with wire harnesses. Production stoppages due to a shortage of wiring harnesses made in Ukraine are expected to last a few months and not go until the year's end, according to a Moody's analysis. German carmakers are particularly impacted, as they rely on Ukraine for the wire harnesses used in their vehicles. The analysis expected this disruption to last less than the semiconductor shortage.

This demonstrates that there is no disproportionate impact on the EV supply chains compared to ICE, meaning that - all things being equal - the share of electric cars produced and sold in Europe does not have to decrease. The latest sales figures from Spain even show that amidst low overall sales, EV sales are growing.

To answer the question on whether or not electric car production can be ramped up in the short-to-medium term (to 2025/27), it is important to understand how fast the car industry can reprioritise and adjust vehicle production in difficult circumstances.

2021 is a good case in point. Despite the serious semiconductor shortage throughout the year, the volumes of battery electric vehicles finished at the levels slightly higher than expected a year before, at 1.2 mln units despite the much lower overall car sales. This is due to two factors:

1. the EU car CO2 target in 2021 that forced carmakers to sell the minimum share of EVs needed to avoid fines, and
2. the prioritisation of lower volume and more profitable (and higher emitting) models that resulted in the need to sell more EVs to compensate for higher average CO2 emissions.

The fast reprioritisation - in the face of the chip crisis - towards the production of plug-in and higher profit models, away from the mass volume vehicles, in the pace of one year shows what is feasible.

Similar quick adjustments were seen in the aftermath of the dieselgate scandal in Europe. As consumers turned away from diesels, their sales share fell rapidly in 2016/17 forcing carmakers to readjust their production lines to produce more petrol cars. This required change in parts of the supply chains, e.g. to produce a lot more three-way catalysts and gasoline particulate filters to clean up petrol exhausts, which carmakers were able to navigate.

These examples demonstrate that the auto industry can, when exceptional circumstances require, reprioritise and adjust production quickly, within a year.

1.2 How many electric cars can be produced by 2025?

The above shows that the automotive industry can prioritise and adjust supply chains quickly when required, or when faced with grave circumstances that epidemics or wars dictate. When it comes to rapidly increasing the production of electric cars, the shortages around nickel and lithium availability are often raised.

So, if similar prioritisation in terms of the maximum availability of critical metals - battery-grade nickel & lithium - were seen up to 2025, how many electric cars can be produced? T&E used the BloombergNEF data to analyse the global volumes of nickel and lithium battery grade material available for EVs, as well as battery cell capacity (nickel-based and LFP chemistries), to answer this question. This is based on the nameplate capacity of the confirmed company plans but does not take potential technical issues or unforeseen circumstances into account. All **assumptions, methodology and uncertainties are detailed in the annex**.

Lithium & nickel availability

In 2022, when we remove volumes needed for stationary storage, electronics, buses and other e-applications, the following maximum volumes are available globally, i.e. in the mining & refining pipeline based on nameplate capacities:

- Around **380 k tonnes[2] of refined battery grade nickel** (used in nickel-rich (NMC) lithium-ion battery chemistries for EVs), rising to 390 k tonnes in 2023 and 400 k tonnes in 2025;
- Around **326 k tonnes[3] of refined lithium hydroxide** (used in NMC lithium-ion batteries), rising to 500 k tonnes in 2023 and 685 k tonnes in 2025;

[2] Tonnes of metal contained
[3] Tonnes of lithium carbonate equivalent

- Around **100 k tonnes of refined lithium carbonate** (used in nickel/cobalt free (LFP) lithium-ion battery chemistries for EVs), rising to 260 k tonnes in 2023 and over 380 k tonnes in 2025.

Table 1: summary of the maximum raw materials & gigafactory availability

Year		2022	2023	2024	2025
k tonnes available for BEV (BNEF) (w/o stationary storage, electronics, bus, etc)	Class 1 Nickel	378	393	400	402
	Nickel without RU supply	314	327	332	334
	Lithium hydroxide (NMC)	326	503	623	685
	Lithium carbonate (LFP)	100	259	336	381
Gigafactory capacity for BEV (70% of overall capacity from BNEF)	GWh	814	1,118	1,502	2,485

Battery & electric car production to 2025

It takes around 1 year between the materials being mined/refined and turned into batteries to be used in electric cars, so for the purpose of this analysis T&E includes a 1 year delay between the availability of the battery grade materials and the supply of battery electric cars. On top, T&E has also incorporated the respective capacity of battery gigafactories available in 2022-2025 (also derived from BloombergNEF) to ensure the battery cells can actually be produced.

The results show that:

- Taking the maximum supply of lithium, nickel and battery factories to produce both NMC and LFP chemistries, **14 million battery electric vehicles can be produced globally in 2023**. This is **55% more BEV than the expected market** for BEV (derived from LMC Automotive in 2023) that follows the regulatory requirements. **In 2025, 21 million BEV can be produced globally** taking both the material and gigafactory capacities into account, which is almost **a half more than the global market** expected currently. This shows that the current BEV supply is not constrained by raw materials, rather by the minimum compliance with regulatory requirements by car makers.

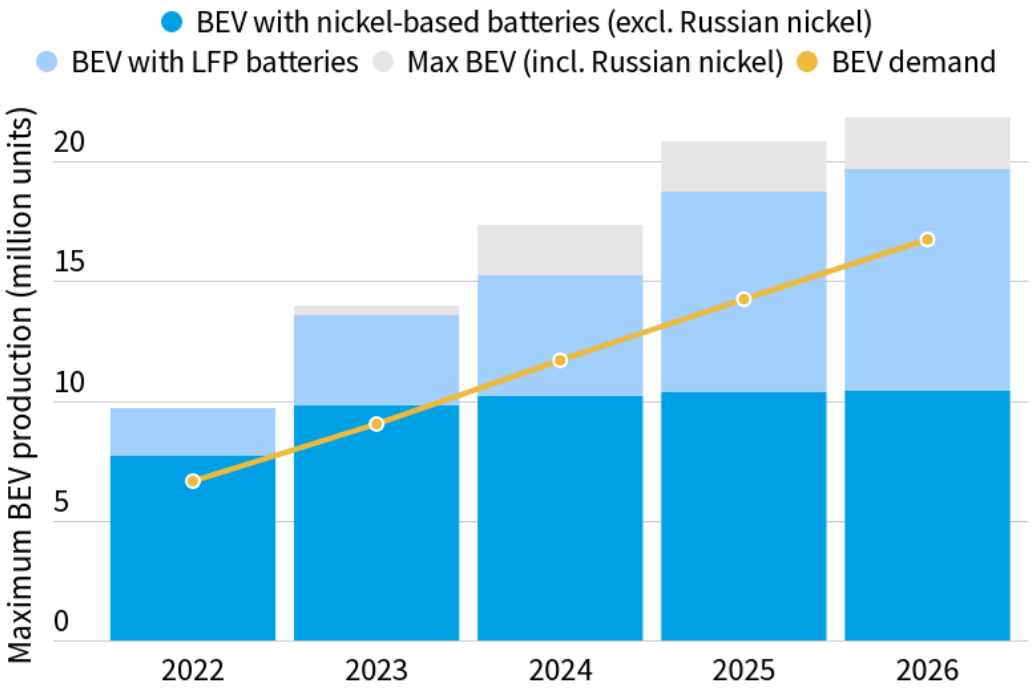
- When only the **lithium** capacity is considered, 10 million NMC batteries and almost 4 million LFP batteries can be produced in 2023. Lithium carbonate and, to a lesser degree, lithium

hydroxide limit an even larger BEV growth in 2022-23, while nickel sulfate becomes a limiting factor from 2024 to produce even more.

- The battery gigafactory capacity is above the max capacity of both lithium and nickel. The gigafactory capacity for nickel-based chemistries will be dominant until 2025, accounting for about 80%. The LFP battery production capacity will add 4-5 mln BEVs annually by 2024, rising to 8 mln in 2025, allowing for a higher global BEV supply overall and alleviating the nickel shortages. These figures do not include the additional capacity that is being announced now but is not fully confirmed and assumes only 20% of gigafactory produce LFP, so are on the conservative side.

- When it comes to **nickel**, there is enough battery grade nickel to produce the maximum amount of 11 million nickel-based batteries in 2023, but it becomes a bottleneck after that. For example in 2025, 33 million nickel-based batteries could in theory be produced in all the factories, but there is enough nickel to produce just 12 million BEV. This is slightly below the expected overall demand but will be compensated by the increasing shift to the LFP battery chemistry that does not use nickel.

- When the nickel sourced from Russia is removed (in case of sanctions targeting the raw material), the 2023 forecast would not change as lithium is currently the limiting factor to an even larger production of BEV. But in 2025 the global production would be 19 mln BEVs (instead of 21mln).



Source: T&E modelling of the global BEV production based on maximum raw material (lithium and nickel) and gigafactory nameplate capacities from BloombergNEF. Global passenger BEV demand from LMC Automotive's Global Hybrid & Electric Vehicle Forecast (Q4 2021).

This analysis demonstrates that there is sufficient quantity of battery grade materials and battery cell production capacity to not only meet the expected BEV market up to 2025, but even to increase EV battery supply globally by at least 50% in the coming years compared to forecasts. On the current data, lithium is tight in the next 2 years, while nickel becomes a bottleneck to an even bigger growth from 2025 (however, more supply is expected to come online, notably from Indonesia). Even without the additional nickel, switching to LFP allows to increase BEV supply by 4-5 mln in 2023/24 already.

As regards the availability of **semiconductors**, LMC Automotive data seen by T&E shows that there are enough chips to produce 72 mln passenger cars in 2022. If carmakers prioritise BEV in the short term, these require approximately double the amount of chips compared to a conventional car (1000 for ICE vs 2000 for EV). This shows that in the case of such a prioritisation, there would still be enough chips available in the short term to ramp up the EV supply (while the overall car sales would decrease).

Thus, if prioritised for BEV production, supply of battery electric vehicles can be significantly ramped up in the coming years, which means a faster deployment of EVs is feasible in the short term up to 2025.

2. Availability & costs for the European market

How fast Europe will switch to electric cars - and how much raw materials this will need - is decided now, in the EU car CO2 standards. What's currently on the table will not speed things up until the late 2020s. On the current car CO2 targets, around 20-25% plug-in cars will be sold in 2025-2029, a lot less than can be based on the market dynamics and carmakers' own EV plans. Given the geopolitical imperative to wean Europe off Russian oil fast, Europe must ramp up electrification a lot faster in the coming years. This is why a group of 25 pan-European NGOs has asked Europe to increase its 2025 goal to 50% EV sales. This has the potential[4] to save more than half a billion barrels of oil by 2030.

The above analysis on raw material volumes is global, and the question is how much of the raw material can be secured (i.e. imported) into Europe short-term. To go as high as half of all sales to be electric by 2025 - on the current sales volumes - 5.5 million electric cars will need to be sold in Europe in 2025[5]. This is around a quarter of the maximum BEV supply that can be produced globally in 2025: given that around a quarter of electric cars sold globally in 2021 were in Europe (including the UK and Norway), this is feasible. The numbers are still within the global capacity of the nickel-based batteries alone, but in reality it is likely to be a mix of lithium-iron-phosphate (LFP) batteries that do not use cobalt or nickel and nickel-based chemistries such as NMC or NCA (used in higher range Tesla cars).

Given the global growth in electric car sales, a mix of smart policies will be needed to ensure that a sufficient supply of BEV reaches the EU market, including:

- Higher EU car CO2 targets for carmakers in 2025 and 2027 to ensure they ramp up EV production/supply chains in Europe to meet the higher demand.
- Smart incentives, especially for corporate fleets and leasing to go for BEV.
- Targeted measures on the infrastructure side, notably faster installation of private charging at work and home, to aid the accelerated uptake.
- Producing more efficient and appropriately-sized electric cars will also help, with 40-60kWh batteries enough for most EU drivers' needs.

However, Europe is not alone in trying to ramp up the electric car market; China and the US - two other major vehicle markets - are doing the same. The above policies will help on the carmaker and consumer side, but they will not guarantee that sufficient quantities of the global raw material exports will be available for the European market until 2025. Diplomacy and political will are needed to secure raw materials into the European market, more on which in the recommendations section.

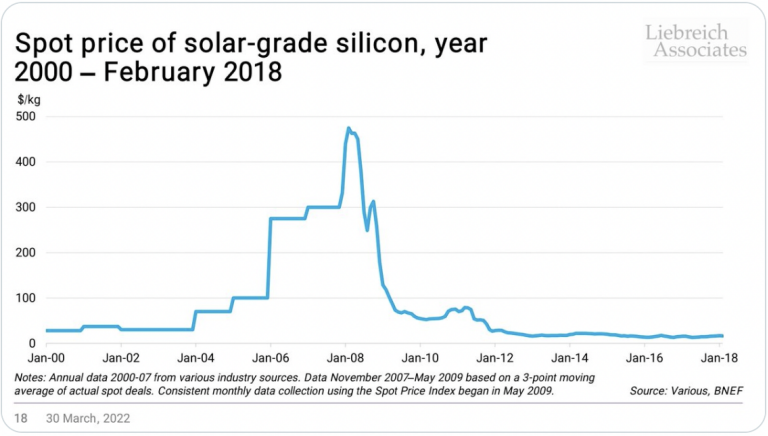
Costs concerns

The market for critical raw materials such as lithium and nickel is currently very tight. Many in the industry claim there is simply not enough lithium to meet all the carmaker EV plans. As a result, the prices for lithium carbonate equivalent have risen up to 500% since last year, while nickel prices have exceptionally reached record levels last month on the London Metals Exchange. This is fueling fear and uncertainty.

[4] T&E analysis on this will be published in mid-May 2022
[5] based on the LMC Automotive forecast of 2025 EU car sales

Costs as a result of the tight market are a legitimate concern. Rising costs for raw materials may have a knock-down effect on the cost of electric cars and delay the parity point at which their price matches conventional cars enabling the mass market. E.g. one analysis estimates that if the high spot market price of nickel seen last month was translated into the battery cost, it would raise the price tag by 6%. With batteries representing at least a third of the cost of an electric car, some carmakers have already started raising the prices for electric cars as a result.

There are short-term and structural reasons for these high prices. Structurally, commodity markets are prone to super-cycles: extended periods of boom and bust. Years of under-investment in new metals, long project lead times and a sudden growth in the market for EVs spurred by climate regulations have all resulted in the current tight supply-demand balance. Mining companies, after years of low returns, might also be enjoying the high prices on the spot markets and might be unwilling to increase the metal volumes available for purchase too quickly.



But such price spikes are not new and do not represent a long-term market trend. Similar spikes in the price of silicon in 2008 (shown on the left from Michael Liebreich's tweet) prompted many to question the scalability of the solar panel industry. Fast forward 12 years, and the price of silicon has stabilised, while over 25GW of capacity of solar PV was installed in 2021 in Europe alone. In the case of transport, concerns as to the shortage of oil fueled the arguments that the world cannot switch from horses to combustion cars in the early 19th century. Two centuries on one can see in every city and motorway of the world whether those fears materialised. We are still waiting for Peak Oil, while a lot of new technology (e.g. fracking) and oil fields have been discovered in the meantime (with damaging consequences for the environment). With market forces at play, innovation, investment and new supply from primary and recycled sources will similarly resolve the current short-term spike in raw material prices.

There are more immediate factors at play that exacerbate the price trends. Covid-induced disruptions in supply chains are delaying production, shipments and expansion plans. And the war in Ukraine has only added to the problem. A lot of this is temporary and is not expected to have a lasting effect on the EV market; a lot of mining and recycling companies are already reacting to the high price and announcing expansions. The nickel price seen in the LME in March was due to a specific case of market frenzy and the prices climbed back down shortly afterwards. It also needs to be stressed that only a small part of the raw materials that car and battery makers purchase comes from spot markets.

Depending on a manufacturer, up to three-quarters of lithium and nickel are often secured via fixed-term contracts with the prices agreed beforehand, meaning the effects of the temporary high spot prices are not impacting the EV production costs directly.

In a nutshell, the currently high prices seen for critical metals are a temporary phenomenon given the super-cycle nature of commodity markets. With Covid disruptions and, hopefully, the war subsiding - and new supply coming on stream - the prices are likely to stabilise in the next few years.

3. Supply mid to long term

When we look longer term beyond 2025, a lot more battery demand and a lot more options to meet that are available for European companies. The bottom line is that there is no shortage of lithium or nickel in Earth's crust. The 2022 US Geological Survey estimates the known global reserves of lithium at 22 mln in 2022 (resources of lithium are in order of 89 mln tonnes vs 100k tonnes mined in 2021) - enough to last for hundreds of years even before the circular recycling loops are accounted for. Similarly, at least 95 mln tonnes of nickel reserves are known (vs 2.7 mln extraction), which suggests the material availability will not be a limiting factor.

Reserves do not mean available for battery production on time, where the growth in capacity to source (or extract from existing batteries) and refine the metals is key. Driven by the battery market, McKinsey expects the lithium supply to grow by 20% a year from now to 2030, resulting in sufficient volumes available if all projects, including the new cleaner lithium extraction technology, come online. Innovation & substitution, investments into new supply and, towards 2030, growing supply from recycling streams will all help ensure supply-demand balance mid to long term.

First, substitution of scarce metals is a key trend that we've started seeing in the electric car market. The concerns over supply of cobalt and nickel are pushing auto makers to switch to alternative technologies. LFP batteries (sometimes with the addition of manganese, or LFMP), previously seen in Chinese brands and buses, are replacing the nickel and cobalt-rich batteries found in global EVs fast. Volkswagen, Tesla, Hyundai and Stellantis all plan to shift to LFP for their affordable models. On the other hand, innovative solid-state chemistries might be an answer for premium vehicles, and are expected to enter niche applications by mid decade. By 2027, Benchmark Minerals Intelligence expects around 100GWh of solid-state battery capacity available.

Second, increasing metal prices are sending a firm market signal to mining companies to ramp up investments in new supply. Many new projects, including a new nickel mine in Tanzania, a lithium one in Argentina, and a number of greener direct lithium extraction plants, including geothermal lithium company Vulcan in Europe, plan to start production from 2025 onwards. A lot more nickel supply is also expected to come online in Indonesia in the coming years. Some delays and opposition is expected (and sometimes justified) in Europe: consistently applying the highest environmental and social standards, including a timely and meaningful engagement with local communities, is the best recipe for companies to complete projects on time. On top of some domestic supply of primary and

secondary metals, imports will remain key. That's why (co)investing in sustainable extraction or refining capacity in resource rich partner countries outside Europe is a good strategy for Europe. For EU companies, vibrant and competitive global markets and cooperation with other democratic markets such as the US or Japan will ensure a level playing field and sufficient responsible supply.

Finally, to avoid production curtailment similar to that caused by the chip crisis, carmakers should procure and secure the supply of raw materials now for the increased EV production in the late 2020s. This includes smart procurement policies and strategic partnerships that prioritise long-term contracts over relying on volatile spot markets. This is what Tesla is already doing with nickel, having secured a number of contracts with Vale and others recently. The current vertical integration trend - producing or controlling more of the upstream supply chain in house - will also allow carmakers to reduce costs and become more resilient to global shocks. Procuring raw materials directly also gives the car industry leverage over the environmental and human rights conditions under which they are extracted. Tesla is doing so in New Caledonia by working directly with the mine on issues like tailings management. Volkswagen is also moving to secure sustainable materials in Europe.

4. Conclusions & recommendations

The data analysed by T&E shows that there is no immediate global shortage of key raw materials needed to accelerate EV production: nickel and lithium short-term to 2025. 14 million BEVs max can be produced globally in 2023 already, rising to 21 million in 2025. In theory, this is 50% more than the currently projected market share of EVs. Europe will have to largely rely on importing these raw materials short-term, but it can accelerate electrification of cars, vans and trucks to wean the continent of oil faster. Even going to 50% EV sales in 2025 would require around a third of global production, similar to the share of EVs sold in Europe in 2021. The question is how much of this global supply given the tight market and a growing demand for electric cars will be available for the European market. And at what cost.

This depends on European politicians and companies. China is already using its diplomacy and political clout to solve the high raw materials costs debacle and secure Li supplies for its market. Earlier in March 2022, the Chinese government convened Li refiners, battery makers and OEMs to discuss the lithium situation as it worries that the soaring costs will slow down the market and reduce consumer acceptance. Its companies are in a race to secure global lithium mining assets as well as expand battery production at home and abroad. The US government has invoked the Defence Production Act to boost domestic supply of critical metals. In contrast, the European governments are using their diplomacy to diversify oil and gas supply, flying the earth in search of fossil fuels to replace the Russian exports.

Rather than swapping dependence on one autocratic regime for another, Europe should instead secure imports of critical raw materials in the coming years to make itself independent from oil faster. As opposed to Saudi Arabia or Venezuela, lithium and nickel often come from countries such as Australia, Chile, the Philippines, Canada and Indonesia. Leaving individual companies to buy the extra

raw materials on spot markets will create insecurity and high costs. Just as Europe's leaders are prepared to pay much higher prices for natural gas and oil bought from elsewhere in the world - and are spending a considerable amount of political effort to procure those - giving a fraction of this support and funds to secure nickel and lithium for the European market would ensure the increased sales of electric cars come at an acceptable cost to European drivers.

Table 2: top producers of oil, lithium and nickel in 2021

Top oil producers	Top lithium producers	Top nickel producers
US	**Australia**	**Indonesia**
Russia	**Chile**	**Philippines**
Saudi Arabia	**China**	**Russia**
Canada	**Argentina**	**New Caledonia**
Iraq	**Brazil**	**Australia**
China	**Zimbabwe**	**Canada**
Iran	**Portugal**	**China**
United Arab Emirates		**Brazil**
Brazil		**US**
Kuwait		

Longer term beyond 2025, a number of forces are at play, with domestic supply from a number of lithium and nickel projects in Europe and a growing stream of metals coming from circular recycling loops becoming available to match and tamper exports from outside Europe. Despite the rapidly growing demand and the tight market, the price signals, innovation and substitution should be able to ensure sufficient supply of key battery metals as was seen in other cyclic raw materials markets previously.

Rather than scurrying the world in search of fossil fuels, Europe should use its power and diplomacy to secure critical metals. To do so in the short term (up to 2025) and beyond, **T&E recommends** the following.

Raw material exports short-term

Either through the political arm of the European Battery Alliance (its Ministerial meetings) or via the Commission coordination directly, VP Sefcovic and European governments should:

1. Urgently map the gaps and shortages, if any, that the car companies are currently experiencing to accelerate EV production in Europe. This could include checking there are no major discrepancies in supply between battery and car plants in different member states.
2. **Use diplomacy and trade relations imminently to secure additional supplies**, notably of lithium from Australia and South American countries, and nickel from Canada and Indonesia (as some companies are already doing) starting with 2022. This may include 1) ensuring parts of the current global production are set for European companies, 2) getting supplies from currently underutilised mining projects or 3) committing to support additional capacity investments. High environmental and human rights due diligence standards should underpin any such agreements in line with about to be agreed European battery regulation. The EBA's Ministerial meeting can be called as soon as possible to coordinate the actions on this.
3. Convene and, where appropriate, work with or put pressure on the mining companies (e.g. Rio Tinto, Albermale, Anglo American and others) to make the maximum raw material supply available and ensure it is traded freely on the spot markets (or available for fixed-term contracts) under the level playing field for European companies.
4. As a last resort in case of acute shortages, coordinated purchasing - including financial support or price guarantees - can be considered as is currently planned with the gas supplies.

Similarly, European car makers should without delay get their act together and secure sufficient volumes of key raw materials in line with at least the levels of their own EV commitments. This includes:

1. Mapping and signalling the volumes (& product specifications) of the battery metals they will need up to 2030. This is key to give the metals industry the visibility of the market needs.
2. Singing fixed-term contracts with mining or recycling companies providing supply until 2025 and actively setting environmental and social standards under which conditions the materials are sourced (e.g. on the conditions for waste disposal or the use of renewables on site for refining).
3. Entering partnerships or investing in existing and new mining or recycling operations directly to secure the supply. High environmental and human rights standards must be part of such contracts and procurement to ensure responsible supply.

Supply of critical metals longer-term

Mid-long term, a lot more raw materials can be supplied within Europe, both from primacy (mining) and secondary (recycling) streams. Smart industrial policy is needed now to secure domestic and responsible supply of critical raw materials from 2025 onwards, alongside exports. This includes:

1. Easy to access European and national funding (for feasibility studies, pilots, loan guarantees, etc) for European companies in the mining and recycling space to secure domestic resources, always underpinned by strong environmental and social conditions. Programmes to support innovative technologies to produce metals with less footprint - e.g. direct lithium extraction (DLE) and direct lithium to product (DLP) - should be prioritised.
2. Accelerated support and funding to boost the lithium and nickel refining capacity for the European market. This can be done domestically - e.g. in Scandinavia near the nickel reserves

or Portugal near the lithium reserves - as well as in partnering countries abroad where mining is happening (e.g. in Indonesia, Chile or African countries) that can also form part of EU's investment aid.

3. Creating a **centralised authority to map and look after the security of supply for critical metals for the European Green Deal**. This can be done either under the aegis of the European Battery (or Raw Materials) Alliance or directly by the European Commission. The EURATOM agency currently ensures supply security for nuclear fuel across the EU. If companies and individual governments fail to secure the metal exports by 2025, a centralised authority should be created. The authority should:
    - Monitor and map the supply needs and signal shortages on a 5-year basis, including an early warning system in case of acute problems
    - Have powers to review the supply chain policy of European automotive, battery, energy and other companies and require them to step up procurement measures where significantly insufficient supply has been secured
    - Coordinate national diplomacy efforts vis-a-vis global resource-rich countries and ensure consistent and equitable supply across EU member state markets
    - Support joint purchasing/price guarantees where appropriate
    - Advise the relevant chapters in EU trade agreements
    - Follow global trends and developments in the market to advise European policy-makers

4. Clarity to the upstream market on the volumes needed, i.e. the size and speed of electric vehicles penetration that is driven by European regulations. Europe should firmly confirm its goal to 100% electric car and van sales from 2035, matching this with a similar commitment on the trucks side. This is key to business case and commercial planning.
5. Rightly sized, often shared and - above all - efficient electric vehicles will also help taper the demand for critical raw materials. This entails local, national and European levels of government working together to create the right conditions for a smarter mobility system overall.

Not only a lot more supply from mining, but also a lot more potential from the battery recycling streams will be available in the future. Smart policies to keep end-of-life batteries in Europe and recycle the highest possible yields of critical metals will be key to benefit from such urban mine assets. Accelerated implementation of the new European battery regulation is key to not only secure that, but to ensure that the entire battery value chain in Europe, including global exports, is sustainable. Importing some raw materials will likely continue mid-long term, so robust horizontal environmental and social due diligence requirements, alongside a verifiable traceability system, will also be key. Ultimately it is preparing today and having smart policies to help the domestic industry that will help. Searching the world for fossil fuels will not.

Further information

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Annex: analysis methodology

The BEV production with the maximum available raw materials and gigafactory capacities are estimated with the following hypotheses:

- This first order analysis is limited to a short time frame up to 2026 as capacity announcements after this are assumed to be too speculative.
- The refined nickel sulphate maximum capacity comes from BloombergNEF's tracker of battery-grade nickel projects (nameplate capacity commissioned according to companies' timeline). In this briefing, quantities of nickel are expressed in terms of k tonne of metal contained. According to BloombergNEF, Russia provides 17% of class 1 nickel.
- Lithium carbonate and hydroxide availability is defined from Bloomberg's tracker of mining and refining nameplate capacity. T&E forecasted the split of lithium raw material between carbonate and hydroxide refining based on the expected maximum demand and bottlenecks in mining or refining capacities. In this briefing, quantities are expressed in k tonne of lithium carbonate equivalent.
- Nickel-based cathode can use different quantities of nickel depending on chemistries. NMC-622 is assumed to be the most representative chemistry as a first-order approximation.
- As lithium and nickel are expected to be the main bottlenecks, other materials (cobalt, manganese, graphite, phosphate...) are not included in the analysis but could become bottlenecks when lithium and nickel capacities are expanded.
- T&E assumes that a 60kWh battery is representative of the average BEV battery on the market. Potential growth of battery capacity would raise supply uncertainties, so carmakers are expected to keep reasonable battery sizes or even to opt for downsizing in the future. The maximum BEV production capacity is based on the split between cars with LFP batteries (use of lithium carbonate), and nickel-based batteries (use of nickel sulfate and lithium hydroxide). Results are given as the number of BEV equivalent without PHEVs, so the number of plug-ins vehicles equivalent would be higher as PHEVs with smaller batteries would replace part of BEVs.
- Battery gigafactory capacities are derived from BloombergNEF tracker of battery factory announcements. Based on BloombergNEF forecast of battery demand, T&E assumes that about 70% of gigafactories capacity can be allocated to passenger BEVs' batteries. For instance, in 2022, Bloomberg expected a 187 GWh demand from consumer electronics, stationary storage, and other applications. That would be 16% of the maximum global gigafactory capacity available in 2022 (1160 GWh), so up to 84% of the capacity could be theoretically allocated to BEV. Nevertheless, as other applications could also be scaled, T&E conservatively assumes a 70% allocation to passenger BEV. T&E assumes that 20% of gigafactories capacity would produce LFP batteries and 80% would produce nickel-based batteries. This 20% LFP share is conservative as LFP share is likely to increase in the future as carmakers order more LFP batteries.

- All mining, refining and gigafactory capacities are used with a 100% utilisation rate of the nameplate capacity to define maximum theoretical production values. Results do not account for potential technical and execution risks that are difficult to predict and highly depend on companies and processes (issues with material quality, losses during cell and battery manufacturing or during set-up of new plants, financial risks, lack of anticipation of different actors, delays due to new Covid lockdown...).
- The global passenger BEV demand is derived from LMC Automotive's Global Hybrid & Electric Vehicle Forecast (Q4 2021 update), excluding commercial vehicles.