COMMODITIES - METALS

The energy transition is going to be highly metal-intensive

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“ The energy transition is going to be highly metal-intensive

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SUMMARY OF CONTENTS

Global warming has now become a fact that we can no longer dismiss

Benjamin LOUVET
Commodity fund manager - OFI AM

Scientists are quite categorical when they say that the only way to contain global warming is to **end our reliance on fossil fuels** and, within the coming decades, completely eliminate our greenhouse gas (GHG) emissions. This is an unprecedented challenge that will require an energy transition on a scale we have never seen before.

For the transition to succeed we will need to deploy all the clean technologies available to us, and this deployment will have to be on a massive scale and immediate. Global warming must be brought under control within the next three decades, which will involve expanding our renewable energy capacity, adapting our industrial production processes, overhauling the transportation industry through electrification, and many other transformations besides.

This means one thing for sure: **demand for metals in the future is going to be on a whole new scale.** Metals in large numbers and large amounts are going to be crucial for manufacturing wind turbines, solar panels and electric batteries and for rolling out the associated infrastructures; they will thus become the keystone of our transition to a sustainable planet.

This will have repercussions, leading to market strains caused by supply-demand imbalances, major political and geopolitical challenges, sourcing and recycling issues... and this will obviously affect the prices of these commodities.

IEA studies : « The rôle of critical minerals in clean energy transitions » • « Net Zero by 2050 – A roadmap to neutrality »

Global warming is a tangible fact and the human impact is now indisputable

There is no longer any room for doubt: **global warming is a fact.** It began at the start of the industrial era halfway through the 18th century. The concentration of carbon dioxide in the atmosphere increased very significantly during this period, creating what we commonly refer to as the greenhouse effect.

It is also common knowledge based on proven facts that **global warming is, to a large extent, attributable to human activity and the combustion of fossil fuels.**

How can we deliver an effective response and contain global warming?

It has become urgent to contain global warming, which is now a clearly measurable phenomenon: it triggers climate events that are undoubtedly going to intensify in the coming decades, causing very substantial physical and material damage.

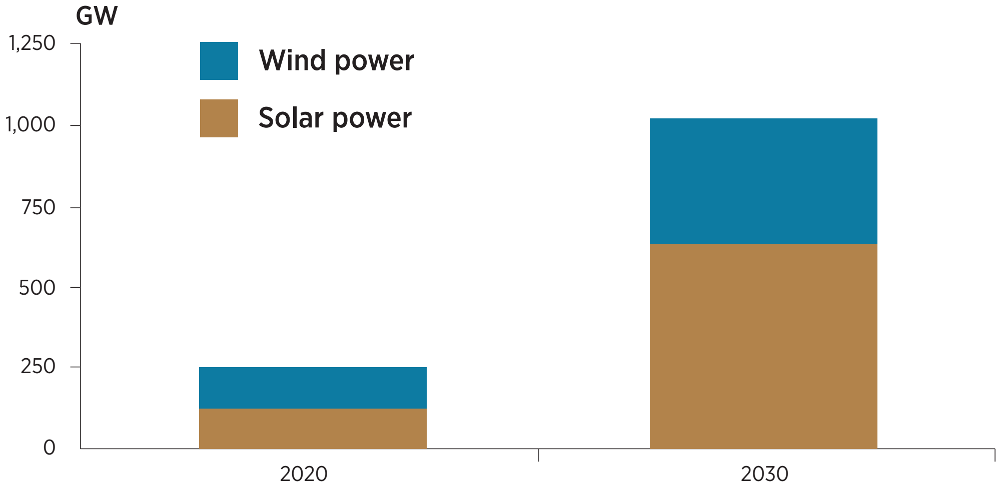
Fossil fuels play a key role in the emission of greenhouse gases, so **the top priority is to organise the world's energy transition:** this means pulling out of fossil fuels and building a future based on the no-carbon or low-carbon energies at our disposal. For the time being, these energies mainly comprise hydropower, renewable solar power and wind power, along with nuclear power, although the latter is highly contentious.

So we need to significantly speed up the pace at which we are developing low-carbon energies if we are serious about achieving the energy transition and about our chances of sustaining a habitable planet. The International Energy Agency (IEA) is the body that helps OECD countries define their energy policies; before the summer of 2021, it published a roadmap describing what needs to be done if we are to comply with the Paris Agreement, which aims to keep global warming to "well below 2°C" by 2100. The report is entitled "Net zero by 2050 – A roadmap to neutrality" and points out that the world must achieve zero net emissions by 2050 if it is to meet this target.

The IEA sets out the changes that need to be made to meet this goal. Remaining on a net-zero trajectory by 2050 will require the immediate and massive deployment of all the effective clean technologies available to us, starting right now. Eliminating fossil fuels will give electricity usage a key role as an energy vector. So it will certainly require energy restraint and energy efficiency to meet this target, along with the development of a hydrogen and biogas industry and nuclear power plants; yet much of our energy future is going to depend on the massive deployment of renewable solar power and wind power. The IEA has calculated that the amount of photovoltaic capacity that needs to be installed each year between now and 2030 to meet our commitments is 5 times greater than the record amount that was installed in 2020 (130 GW). To get a better idea of the challenge that lies ahead, the IEA explains that this implies installing no less than the equivalent of the largest solar power plant currently in activity EVERY SINGLE DAY during this entire period!

The IEA emphasises the importance of wind power too, saying that the amount of capacity to be installed each year between now and 2030 will have to increase 4-fold...

Solar and wind power capacity to be installed each year between now and 2030 in a net-zero trajectory

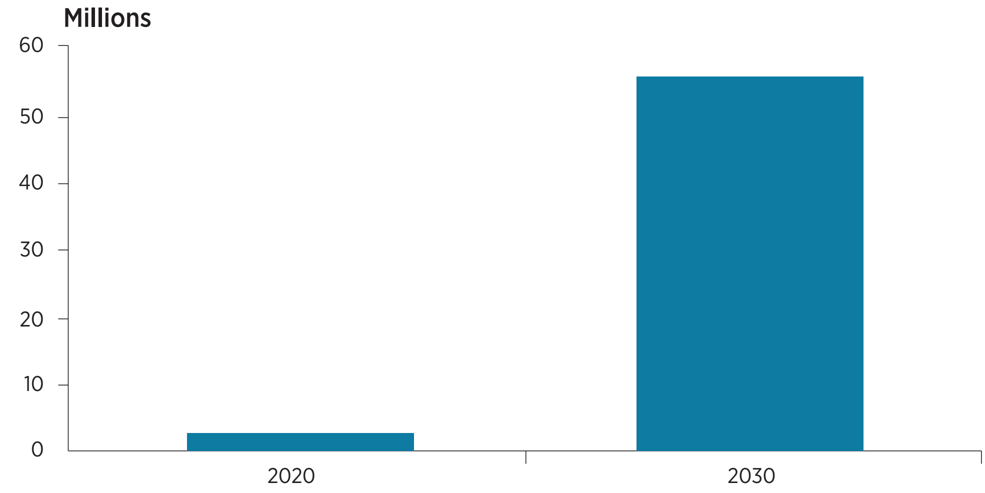


Source: IEA, 2021

Besides thoroughly transforming our global energy system, **there are other industries that need to be decarbonised if we are to tackle global warming successfully.** The transportation sector, for instance, accounts for as much as 27% of the planet's greenhouse gas emissions. So it is essential to eliminate combustion engines and electrify the world's cars within the next few decades if we are to meet our planet's sustainable development goals.

In the IEA's "Net Zero by 2050" scenario, sales of electrified vehicles will account for 60% of global sales by 2030 versus about 5% today. Once again, this will require a massive and speedy transition of an entire industry on a global scale.

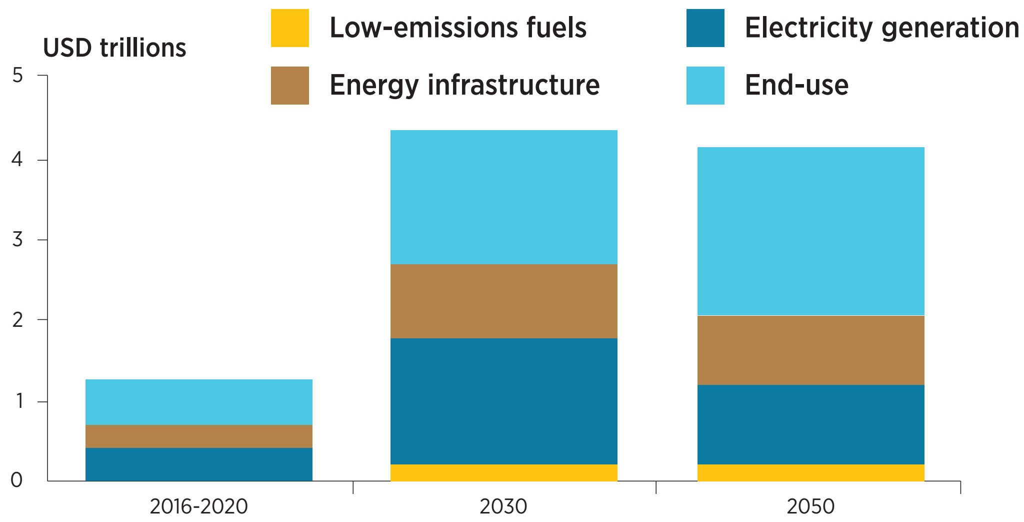
Sales of electrified cars in a Net-Zero by 2030 trajectory



Source: IEA, 2021

These profound transformations will, of course, rely on **massive amounts of capital being redirected to the deployment of clean technologies.** The IEA calculates that annual investments in such technologies in the energy sector alone will have to triple from $1.2 trillion in 2020 to $4.3 trillion per year by 2030.

Clean energy investment in the net zero pathway



Source: IEA

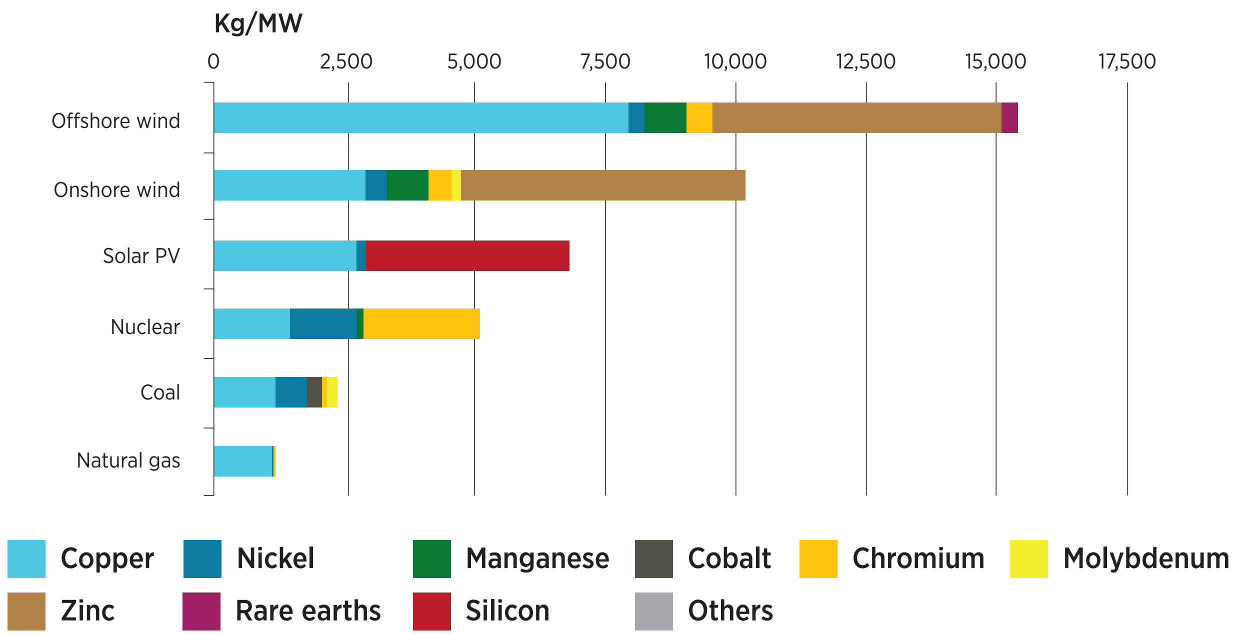
Such an overhaul of our energy and economic system poses not only an industrial challenge; there is another major difficulty that has so far tended to be overlooked. There is no magic form of energy out there and we cannot make electricity from sunshine or wind alone but rather by using a transformer that converts wind or solar energy into electricity. And these transformers have material properties; they are made from metals, concrete and polymer fibres.

It is urgent to bring global warming under control. Organising the energy transition is the top priority.

An unprecedented impact on demand for metals

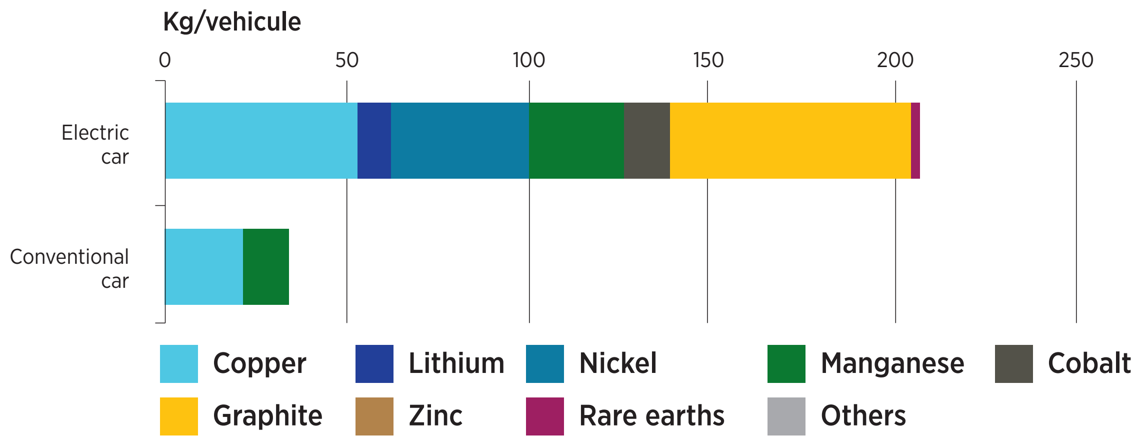
A number of bodies have already sounded the alarm, including the IEA, of course, but also the World Bank, the European Commission and the OECD. A society based on the generation of renewable energy is much more mineral-intensive than one based on fossil fuels. Renewable energies consume far more metals than conventional energy technologies (like nuclear power and coal) do. This also applies to electrified vehicles, the manufacture of electricity storage solutions, the production of green hydrogen etc. So the rapid deployment of clean energy technologies will push demand for these metals up significantly.

Minerals used in clean energy technologies



Source: IEA, 2021

Minerals used in electric cars compared to conventional cars



Source: IEA, 2021

This will trigger a massive increase in metal demand in the future

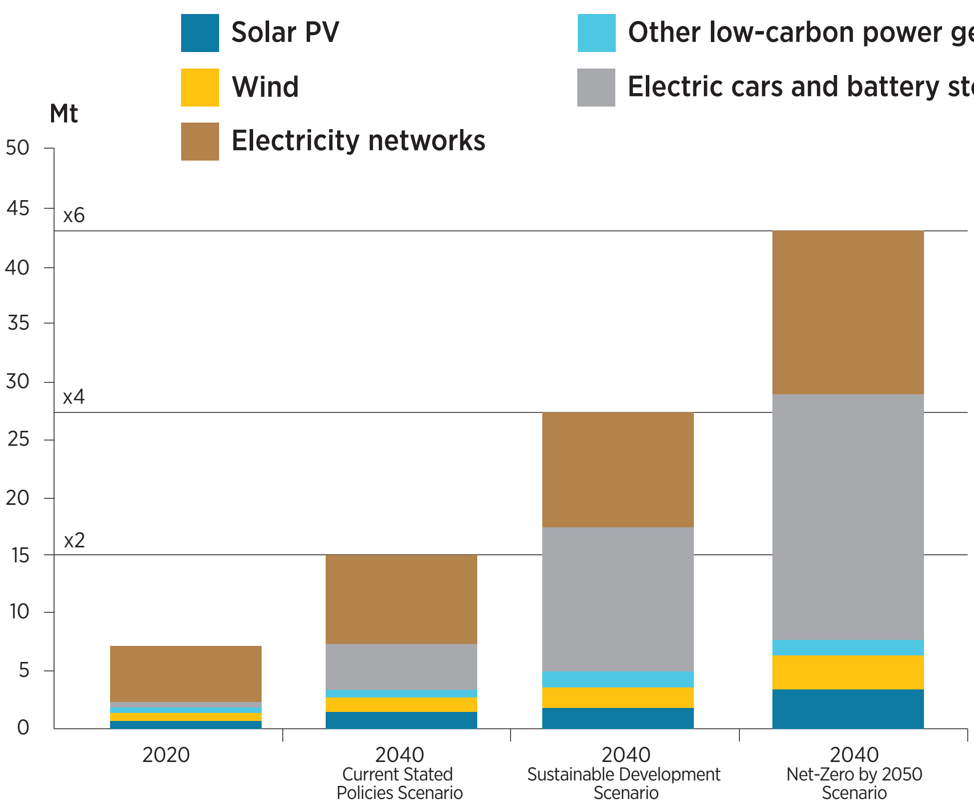
The IEA's most conservative scenario (referred to as the Stated Policies Scenario, or STEPS) only factors in the government measures that have already been announced so far and it would leave us a long way from the target we need to reach in terms of maximum temperature rise; and yet it already sees demand for the minerals used in clean energy technologies doubling between now and 2040.

Under its Sustainable Development Scenario, in which the temperature rise is limited to about 2°C by the middle of the century, metal demand is seen increasing 4-fold.

Under its targeted Net Zero by 2050 Scenario, the IEA sees global warming being limited to less than 1.5°C - in line with the Paris Agreement - and demand for minerals increasing 6-fold within the next 18 years.

We will therefore transition from a reliance on fossil fuels to a reliance on metals within the next few years, which will also create supply and availability problems in the case of some of these commodities.

Future mineral demand for clean energy technologies by scenario, 2020 vs 2040

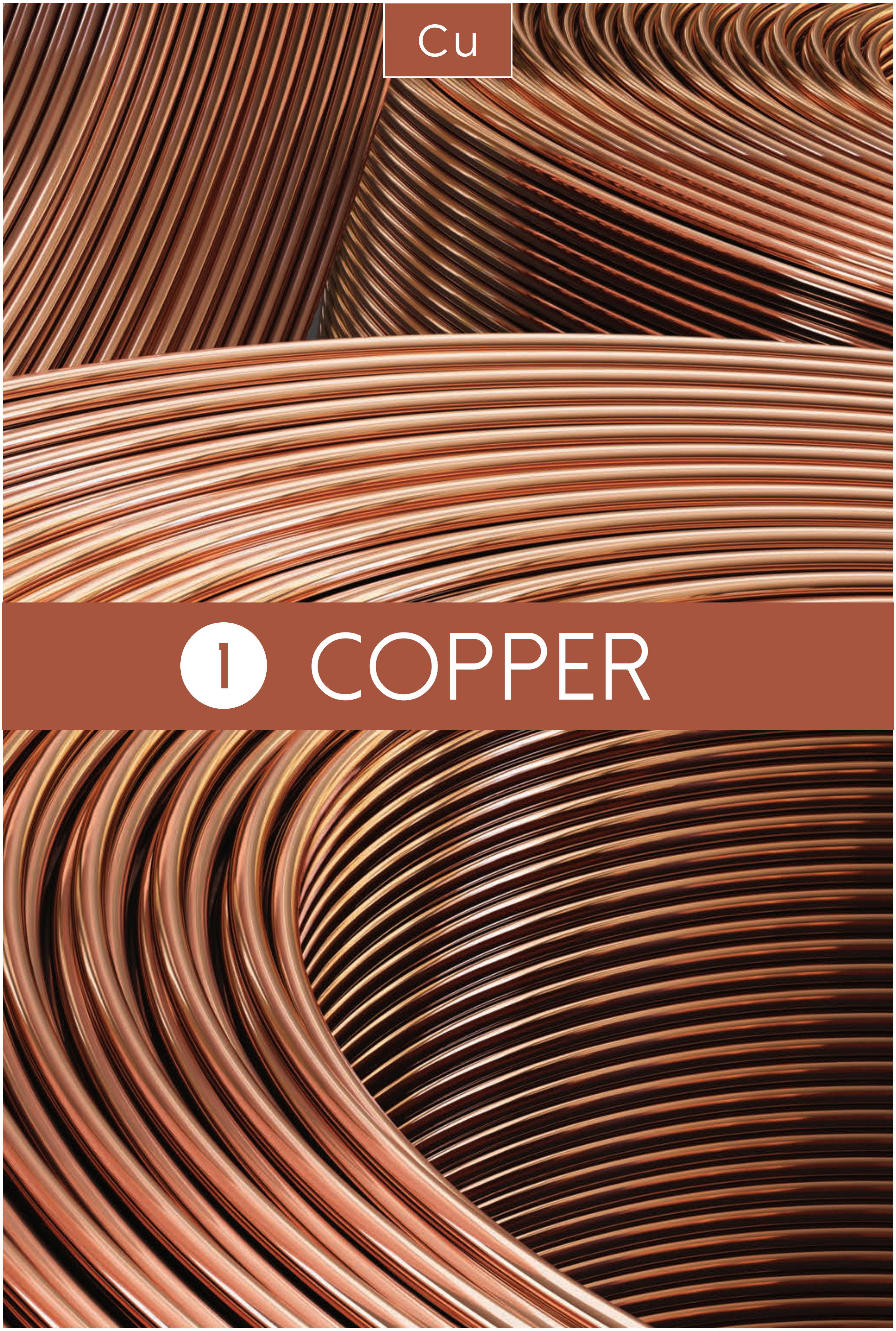


Source: IEA, 2021

THE METALS CONCERNED

Cu

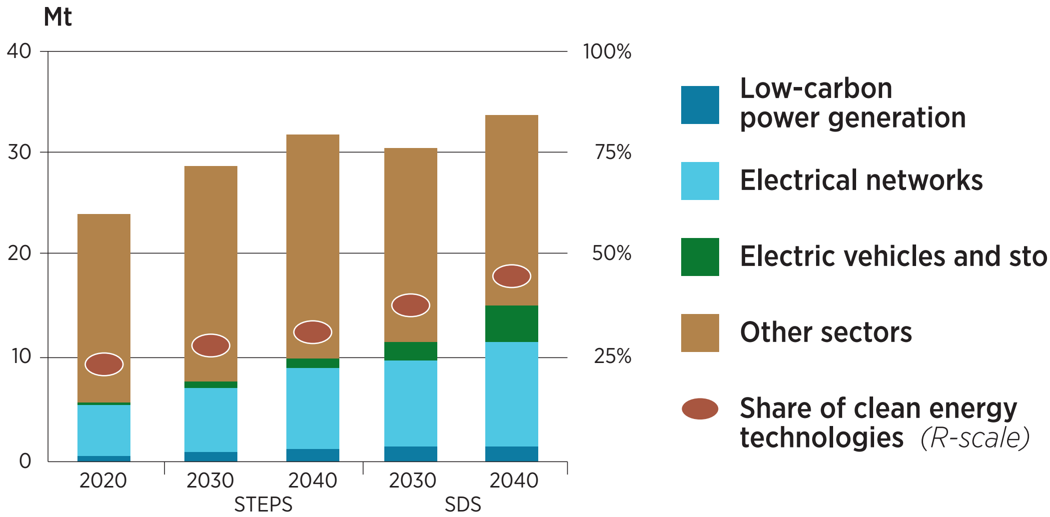
1 COPPER



COPPER

Copper is perhaps the most emblematic of all the metals. It is a very good conductor of electricity and is therefore used in almost all low-carbon technologies but also in electricity networks, which will have to be reinforced considerably as power generation becomes increasingly decentralised. A wind turbine contains between 1 and 5 tonnes of copper depending on its size, while an electric vehicle contains about 4 times more copper than a conventional combustion engine vehicle does. Under a Paris Agreement-compliant scenario, the IEA reckons that low-carbon energies could already account for 40% of copper demand by 2030.

Copper demand by sector



Source: The role of critical minerals in clean energy transitions, World Energy Outlook special report, IEA, May 2021.

The Institut Français du Pétrole et des Énergies Nouvelles (IFP-EN) goes even further: even assuming a high recycling rate (of about 40%), the calculations carried out by the team led by Emmanuel Hache, a prospective economist at IFP-EN, show that by 2050 we might have used up over 90% of the world's current proven copper reserves. The term "reserves" refers to the amount of copper that is technically and economically recoverable. So, unless major technological advances are made in mining techniques, **copper prices will have to rise substantially in order to keep reserves growing** and prevent the energy transition from being compromised by a metal's unavailability.

Besides the matter of availability, another issue is the pace at which demand and supply are going to increase. Low-carbon technologies will have to be stepped up at a phenomenal rate, and this will add to existing demand rather than replacing it. In the case of copper, the development of renewable energy technologies is not going to reduce the amount of copper consumed by the building industry or technology industry. So mining output will have to be able to grow at a pace that keeps up with the accelerating energy transition. Here again, we can learn a lot from the research carried out at IFP-EN. For instance, the Chilean authorities consulted by IFP-EN (Chile is the world's biggest producer of copper) say that they are unable to keep producing copper at the annual growth rate of 4.0% to 4.5% that the energy transition requires (according to the institute's calculations).

Mining output will need to grow at a pace that can keep up with an accelerating energy transition.

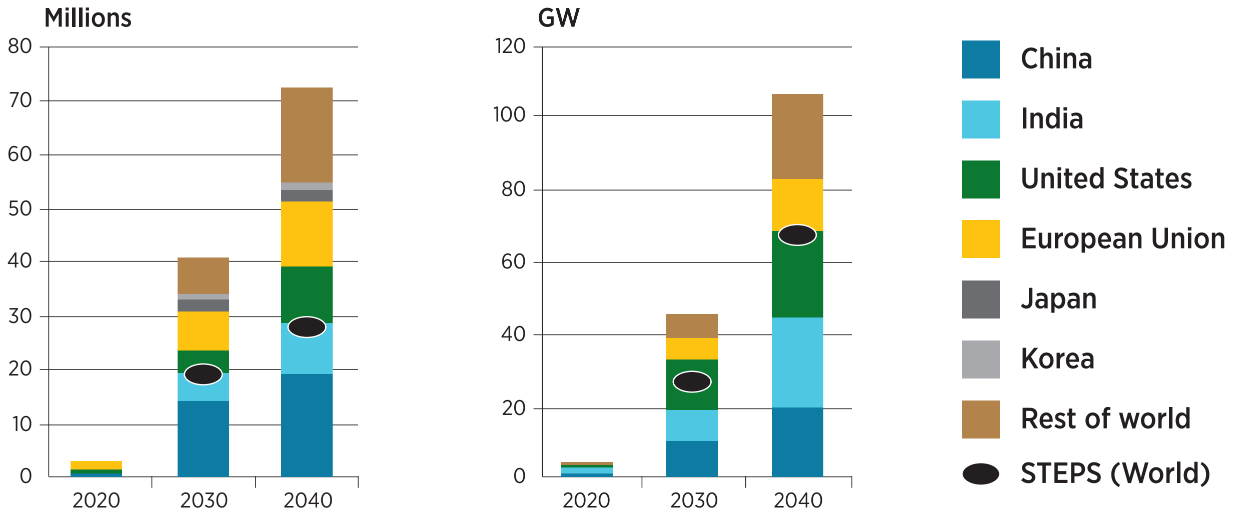
Ni

2 NICKEL

NICKEL

Nickel is nicknamed "the devil's metal" and plays a key role in the transition to sustainable mobility. Nickel is essential for manufacturing batteries and especially lithium-ion batteries, which are the most efficient and by far the most widely used in electrified vehicles. So the use of nickel could soar in the coming years.
The metal is currently used mostly (70%) for manufacturing stainless steel. About 1.5 million tonnes of the 2 million tonnes of nickel produced each year goes towards producing steel. The use of nickel for manufacturing electric batteries currently accounts for about 5% of global nickel demand. Under the scenarios established for the transformation of the transportation industry, the drive towards decarbonisation will imply vehicle electrification on a huge scale and the massive roll-out of recharging capacity; these scenarios therefore suggest that demand is going to grow extremely rapidly over the coming decades.

Electrified vehicle sales (L-scale) and installation of battery storage capacity (R-scale) worldwide under a Sustainable Development Scenario (SDS)



Source: IEA, The Role of Critical Minerals in Clean Energy Transitions, 2020

Demand for electric batteries will therefore soon find itself competing with other uses: the World Bank says that the battery industry alone will require 2 million tonnes of nickel each year by 2050. The European Commission's projections are even more ambitious as they see nickel consumption by the battery industry alone reaching 2.6 million tonnes each year by 2040. So the supply deficit could materialise very quickly indeed.
There is also the quality issue to consider, as not all nickels are alike: Class 1 nickel is extremely pure, accounts for 1 million tonnes of the nickel being produced today and is the only type that can be used to manufacture batteries. Not nearly enough of this high-quality nickel is being produced at present. Most of the production capacity that has been added so far has concerned Class 2 nickel. The low price of nickel in recent years has discouraged firms from investing in the production of the more costly Class 1 nickel.
This could create a problem in the very near future. JP Morgan says that the nickel stocks held by the world's metal exchanges are at their lowest levels since 2007, whereas its analysts already see demand growing by 9% in 2022, driven mainly by the expanding electric battery industry.
Here again, prices are going to have to rise considerably if nickel operators are to speed up their production in order to keep up with increasing demand.

Demand is expected to increase extremely rapidly over the coming decades.

3 ALUMINIUM

ALUMINIUM

Aluminium is omnipresent in today's modern society and **the second mostly widely used metal in the world, after iron.** We can find it being used in a whole range of industries, especially construction and transportation. And now **a new market for aluminium is booming,** that of low-carbon technologies. It is used in photovoltaic panels, magnets, wind turbine nacelles and blades, power grid infrastructures, packaging and lithium battery cathodes, and also to reduce the weight of vehicle body structures... Its many properties make it a critical component of the energy transition, and demand for the metal is therefore going to soar over the coming years.

Here again, the surge in demand for aluminium is going to come up again the limited availability of bauxite resources, bearing in mind that bauxite is a raw material used to make aluminium; aluminium prices are therefore going to stretch considerably. IFP-EN modelled future demand for aluminium in light of the world's available bauxite resources and came to the following conclusions: under a scenario in which the energy transition enables our planet to limit global warming to 2°C by 2050, aluminium production will have used up 64% to 87% of the world's bauxite resources by then. The gap between these two percentages corresponds to the two estimates for bauxite resources identified to date and published by the USGS (United States Geological Survey). The criticality of this metal seems clear in both cases, even under a less ambitious global warming scenario than that stipulated in the Paris Agreement.

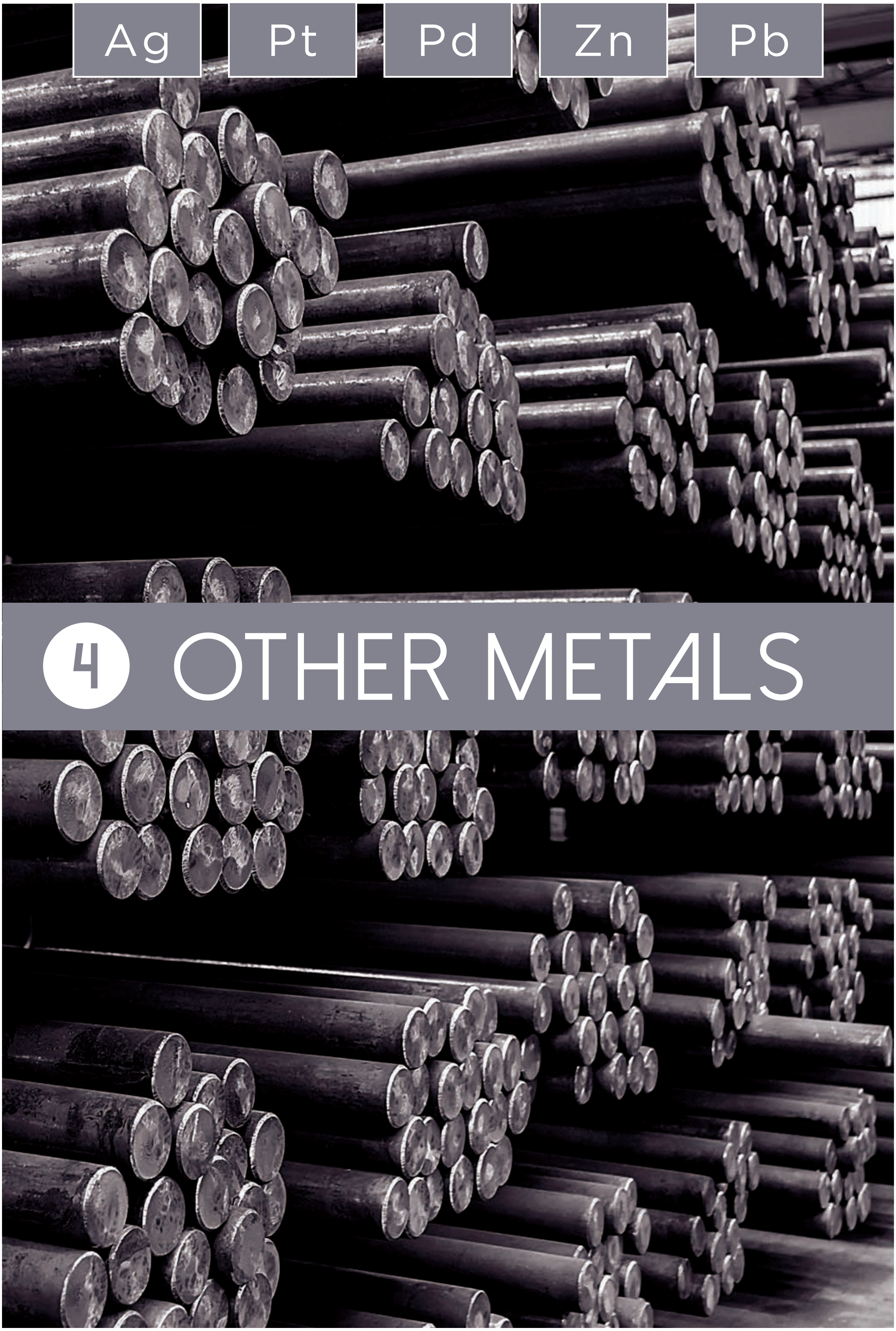
Not only is demand for aluminium going to soar in the future because it is so essential to the energy transition; **prices could also be pushed upwards due to supply constraints.** Aluminium is currently a significant source of greenhouse gas emissions: the production of aluminium is highly power-intensive, which explains why this industry alone currently accounts for over 2% of the world's greenhouse gas emissions (source: International Aluminium Institute, 2021). This, in turn, is closely correlated with the energy mix of the country in which the metal is produced. **A large share of these emissions is generated by China,** which is both the world's biggest producer of aluminium and a country that uses up a great deal of coal to produce its electricity.
The Chinese government is aware of the problem and has adopted a highly ambitious plan geared towards the energy transition and towards decarbonising the country's production process. China was responsible for 28% of the world's greenhouse gas emissions in 2020 and intends to reduce its share to zero by 2060. This means it will have to slash its CO_2 emissions by 90% within the next four decades, while the remaining 10% will involve carbon capture solutions.
So China is going to have to pull out all the stops. This could repeatedly put its domestic production and prices under strain, as we were already able to see very clearly in 2021.

A number of Chinese provinces failed to meet their targets to reduce their energy consumption and greenhouse gas emissions and were forced by the central government to restrict their aluminium production. Aluminium prices reacted immediately by soaring: in fact, this episode helped to push them up towards the historical highs they last reached back in 2007. This episode also shows just how big a challenge the country is going to face in the years ahead if it wants to successfully complete its energy transition. We could see a repeat of these events over the coming years as decarbonisation will involve placing restrictions on production and it will take many years for the country to switch to decarbonised power generation. This is likely to push prices up in the future, both directly (due to occasional reductions in output) and indirectly (electricity prices are probably going to rise because of the energy transition itself, thus affecting the cost of producing aluminium and therefore its end price).

Aluminium's many properties make it an essential component of the energy transition.

Ag | Pt | Pd | Zn | Pb

4 OTHER METALS



OTHER METALS CONTRIBUTING TO THIS TRANSITION

Setting aside the emblematic examples described above, there is a very broad range of other metals that will also contribute to the decarbonisation of our economies and its many technological ramifications.

We could mention silver, for instance, which boasts the physical property of being the metal that bests conducts electricity. For this reason, it is used in solar panels to transmit electricity. It is an expensive metal, however, so industrial firms try to use it as little as possible. The amount of silver embedded in each solar panel has therefore been reduced from more than 20 grammes 10 years ago to 5 grammes today.
But installed solar capacity has kept increasing. A record 130 GW of solar power capacity was installed worldwide in 2020, a year in which the photovoltaic industry gobbled up 3,142 metric tons of silver, corresponding to 12% of global production! If we are to take the Paris Agreement commitments seriously and follow the IEA's recommendations to increase the amount of capacity installed each year 5-fold between now and 2030, we can expect demand for silver to soar.
Especially as silver is not only used in this low-carbon technology but also coveted by the automotive industry for the electric mobility segment. We will not actually find any silver in an electric vehicle battery. But each electric car is fitted with a battery pack, and these batteries need to be connected in order for the electricity to flow, which is why EV manufacturers use silver. So whereas the automotive industry barely used any silver at all just 10 years ago, by 2019 demand from this industry was already accounting for as much as 6% to 7% of the world's silver output.
So with the production of electrified vehicles set to skyrocket in the future, the price of silver will no doubt rise considerably to avoid creating a supply deficit relative to demand.

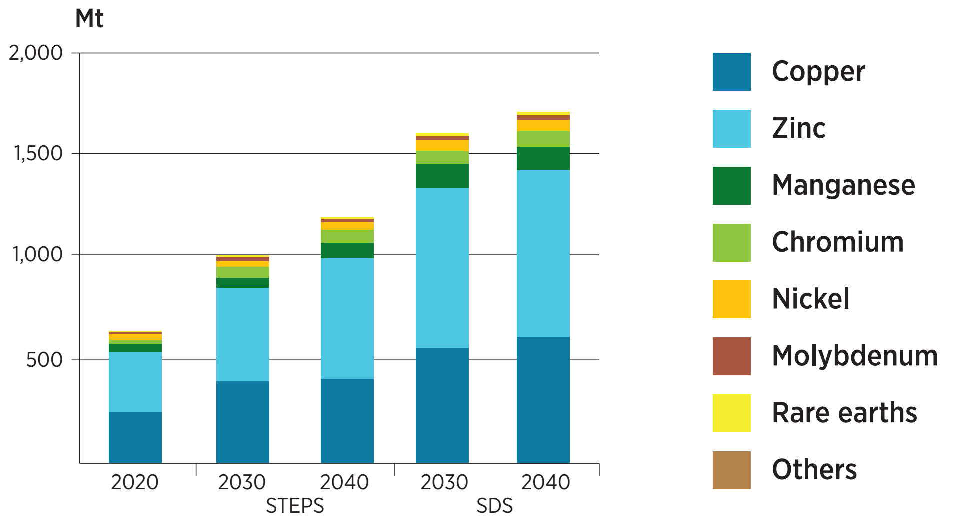
Platinum and palladium are also important components of the automotive production process. The two metals are already used to manufacture the most efficient catalytic converters, thus reducing the emissions generated by combustion engines. A catalytic converter helps to decrease the amount of unburned pollutants in a car's exhaust fumes by converting about 95% of exhaust fumes into less toxic elements. The automotive industry has slowed down recently due to supply constraints (especially semiconductors) but is expected to deliver a strong recovery in 2022, which should provide support for the prices of both these metals. Especially as the **palladium** market is set to find itself with a supply deficit for the eleventh year running in 2022... **Platinum,** meanwhile, will be buoyed up not only by a recovery in vehicle sales but also by the development of a very promising new industry: green hydrogen, which is used for energy storage as part of the energy transition. A lot of platinum is needed to produce green hydrogen because the process involves water electrolysis. Furthermore, the use of hydrogen in the electric mobility industry (for hydrogen vehicles) also requires large amounts of platinum to convert the gas into electricity. This process is carried out by a fuel cell and needs about one ounce (31.10 grammes) per vehicle. **We are therefore convinced that these metals are going to enjoy a strong recovery as of 2022.**

Zinc receives less media attention than copper or aluminium but **should also play a crucial role in meeting the planet's clean energy targets in the future,** as illustrated recently when Canada added the metal to its list of critical minerals.
Zinc is better able to protect metals against corrosion and is also increasingly being used in energy storage. So experts predict that zinc is going to become an essential material in the constantly changing landscape of renewable energies.
Zinc is an essential component in clean energy technologies for a number of reasons:

- Zinc provides protection against corrosion. It is used primarily in the manufacture of galvanized steel to protect it against corrosion in a very broad range of fields, including buildings, bridges, wind turbines and transmission towers. The lifespans of steel structures can be extended significantly if they are protected from corrosion, and fewer primary resources are needed if these structures can be kept in service for longer. In the case of zinc, this means less steel production and, therefore, less need for energy to mine iron ore and convert it into steel.
- Zinc is also essential for manufacturing wind turbines. The manufacturing process requires large amounts of zinc to protect the turbines from corrosion: the World Bank says that 98% of the zinc currently consumed

by the renewable energy industry is used up by the wind power segment. More and more renewable energy capacity is going to have to be developed over the coming years, so there is no doubt that demand for zinc is also going to increase considerably. Under its Sustainable Development Scenario, the IEA reckons that demand for zinc for the purpose of developing wind power alone is going to increase almost 3-fold between now and 2040.

Demand for metals for developing wind power



Source: IEA, 2021

- Zinc is useful for developing other renewable energies too. It is particularly vital for manufacturing solar panels: it is found in the solar cells themselves but is also used as a material that protects the solar panel structure from corrosion. It is also worth remembering that many of the structures forming part of a power grid, such as transmission towers, are made from steel and also require protection from corrosion.
- Demand for zinc for use in energy storage could also increase rapidly. Researchers are working to develop a new type of storage system, zinc-ion batteries, as an alternative to lithium-ion batteries. This new technology is not very costly and is more durable; it is also much safer as it is non-flammable. So it could become a serious alternative to the lithium-ion batteries currently omnipresent in the market. In this case, demand for zinc could potentially surge.

The physical properties of lead currently make it a hugely useful metal for developing renewable energies and managing their intermittence. The metal has a very low melting point and is highly corrosion resistant, making it a crucial component in the development of solar and wind power capacity.
In the case of solar panels, it is lead's very low melting point that makes it so vital. The metal is used to coat the copper strips that join up the cells inside a solar panel. Lead is also used to weld solar panels together without having to heat up the panels to excessively high temperatures; this is useful as panels are, counterintuitively, highly sensitive to heat and to changes in temperature. As there is no need to overheat the panels during the welding process, it is possible to avoid creating microfissures that would subsequently worsen due to the thermal strain put on panels when they are being used. This makes the panels more durable and efficient.

There are alternative solutions out there, but they are less efficient and more costly, which makes lead essential to this type of technology.
Lead's anti-corrosion properties also enable it to play a key role in the development of wind power. Lead makes the subsea cables needed to link offshore wind farms to the land more corrosion resistant and lead-sheathed cables can double the lifespans of such structures (to 50 years versus 25 years for other technologies). Europe's current offshore wind farm projects alone will require more than 3,000km of lead-

sheathed cables. ENTSOE (Europe's electricity transmission system operator) estimates that no less than 45,000km of high and extra-high voltage subsea cables will have to be installed within the next 10 years.
Lastly, lead has been used for energy storage purposes for many years. The advantage of lead batteries is that they have long lifespans (more than 5,000 charging/discharging cycles) and are very low-risk to use, which limits their cost. We expect these batteries to be deployed on a very large scale in small motor vehicles like two/three-wheelers. In Asia, various means of urban mobility driven by such motors (electric bicycles, scooters, rickshaws) are likely to make massive use of such batteries.
The International Energy Agency (IEA) sees demand for lead increasing by 45% between now and 2040 as these uses become increasingly widespread.

A very broad range of metals are going to be used in the decarbonisation of our economies and its many technological ramifications.

Supply issues

Setting aside the issues of volume and production rates, metals are also a matter of political and geo-political concern.

First of all, this is because **the development of renewable energies is not going to solve our energy dependence problem.** Even if the wind does blow and the sun does shine locally, the vast majority of the production of wind turbines, solar panels and electric vehicle batteries takes place beyond our borders, with metals that we do not produce ourselves.

What is true, however, is that **our energy dependence is being transformed by the development of these new energies:** we are relying less on fossil energies but more on metals. And this is very important from a geopolitical perspective because much of our diplomacy currently centres on our hydrocarbon needs. And the countries that produce metals are not the same as those that produce oil. What does this mean for our diplomatic relations with the Democratic Republic of the Congo, for instance, which produces and holds the largest share of cobalt reserves in the world? China, meanwhile, produces almost all the rare earths that are vital to so many different technologies and refines over two-thirds of the world's copper, lithium and cobalt.

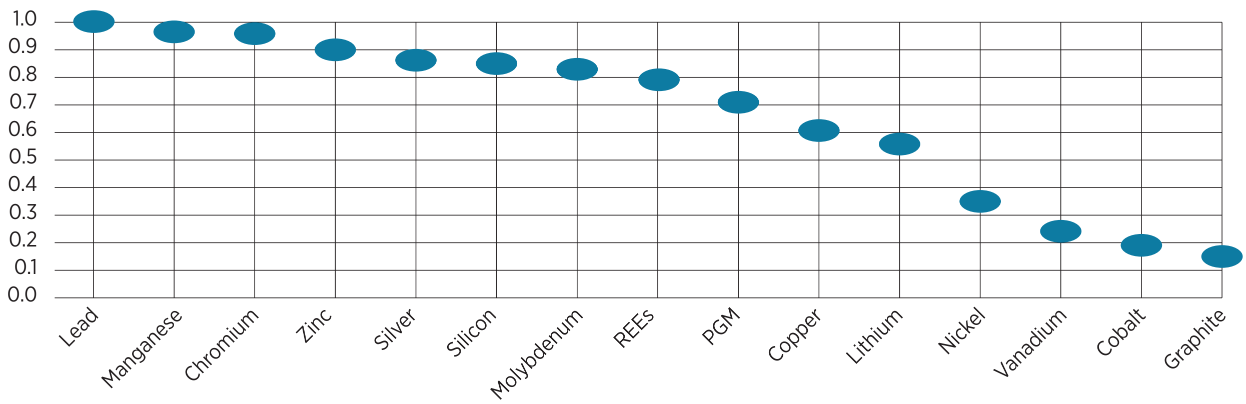
We therefore need to completely rethink our international relations. We also need to consider the fact that the metals industry is often an oligopoly. **Let us take copper or lithium, for example: the world's 5 biggest firms producing these metals account for around 80% of total supply.**

Conclusion

Metals therefore play a key role in the ongoing energy transition and could even blindside us if we are not careful, jeopardising the transition altogether. There are reasons to think that this has already been identified as a potential problem. However, given the very tight schedule ahead of us, we need to make sure the issue remains at the very forefront of our minds. At the European level, for instance, we need to begin by including the mining industry in the EU taxonomy, a reference text that defines which sectors contribute to the energy transition so that the necessary investment flows can be directed to them. This would not give the mining industry free rein but could come with environmental standards and restrictions, as is the case for the other industries already included in the reference text.

On the investment front, meanwhile, the mining and metals industry could offer investors a rare opportunity. The IMF published a report in October 2021 entitled “Energy Transition Metals” that accurately sums up the situation. In it the body estimates that the energy transition will have a very significant impact on the prices of certain metals in the future. It projects that lithium, cobalt and nickel prices will jump several hundred percent over the coming years; the price of copper is seen increasing by about 60%. And these levels are expected to be reached by around 2030, i.e. in 8 years’ time. Moreover, the research team’s sensitivity tests indicate that the risks are clearly to the upside in this scenario, which means that these price forecasts are still on the conservative side.
The IMF also estimates supply/demand ratios for a basket of metals over the period spanning 2021 to 2050. The findings once again are very clear. The ratio is below 1 for the vast majority of the metals in this basket; this points to a supply deficit compared with a massive jump in demand in the future.

Metal supply/demand ratios (cumulative production and demand from 2021-2050)



Source: FMI, “Metals Demand From Energy Transition May Top Current Global Supply”, 2021

The energy transition could prove to be one of the most powerful sector trends ever observed as we shift from a reliance on fossil fuels to a reliance on metals.

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