
INTERNATIONAL
TIN
ASSOCIATION
TIN2030
A Vision for Tin
REPORT 28/03/23

Into the **future**

Looking into the next decade, the tin industry faces unprecedented opportunities and challenges. It is important for us in the tin sector to understand what lies ahead. To build this picture, the International Tin Association (ITA) has consulted widely across the sector to see what the future may hold and what action we should take to secure the future of tin.

Our world is changing fast. With rising geopolitical tensions, climate change urgency and a series of macroeconomic shocks, we expect the next decade will see the emergence of a new divided world, competing for vital resources including tin.

Tin supply chains will need to adapt rapidly to meet these challenges while also working together to manage increased Environmental, Social, and Governance (ESG) expectations and demonstrate how the tin sector is building a better future for everyone.

At the same time, we expect it will become increasingly clear that tin is a vital technology metal. It will glue together all of the electronic and electrical infrastructure needed to digitise the world and reach Net Zero.

Therefore, we firmly believe that the demand for tin will surge.

For all these reasons, we foresee that the next decade will see a wakeup to tin with a new wave of government-supported investment to secure sustainably sourced supply.

As we stand together on the edge of this new era, we at ITA have been engaging with investors, producers, users and ESG experts to begin laying out this vision for tin together. We will use this framework to develop a strategic roadmap that can lead our industry to 2030 and beyond. Thanks to all who have contributed so far, we look forward to continuing the conversation.

Helen Prins
CEO International Tin Association

A VISION FOR TIN 2030

A DIVIDED, COMPETITIVE WORLD SHIFTING *PRIORITIES*

SECURING A SUSTAINABLE FUTURE MAINSTREAMING ESG TRANSPARENCY MOVING BEYOND ESG AUDITS WORKING TOGETHER ON ESG ISSUES

A TECHNOLOGY REVOLUTION DIGITISATION ENERGY TRANSITION SUSTAINABLE TECHNOLOGIES SUBSTITUTION

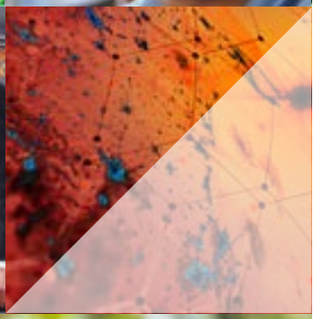
A WAKE-UP FOR TIN
NEW INVESTMENT
NEW RESOURCES
NEW SMELTING
INCREASED RECYCLING

MARKETS

TECHNOLOGY

SUSTAINABILITY

MACRO



TIN2030 Themes

MACRO

A divided, competitive world

SHIFTING PRIORITIES
Opportunities and challenges

SUSTAINABILITY

Securing a sustainable future

MAINSTREAMING ESG TRANSPARENCY
Company value measured by ESG performance

MOVING BEYOND ESG AUDITS
Progressive improvement assured by meaningful standards

WORKING TOGETHER ON ESG ISSUES
A holistic approach to risk management

TECHNOLOGY

A technology revolution

DIGITISATION
Tin surfs the data wave

ENERGY TRANSITION
Climate change brings new opportunities for tin

SUSTAINABLE TECHNOLOGIES
Green technologies for tin supply chains

SUBSTITUTION
Tin use proves mostly robust to price pressure

MARKETS

A wakeup to tin

NEW INVESTMENT
Investors discover a new interest in tin

NEW RESOURCES
Legacy prospects reassessed

NEW SMELTING CAPACITY
A diversified tin smelting industry

INCREASED RECYCLING
Secondary tin supply a priority

MACRO

A **divided**, competitive world

SHIFTING PRIORITIES

SHIFTING PRIORITIES

Opportunities and challenges.

Over the next decade dramatic new market dynamics will challenge the tin industry. Companies will need to adapt rapidly to an increasingly complex and dynamic supply landscape, with unprecedented opportunities and challenges.

Where we are

Decades of relatively stable global trade are being challenged at multiple levels by a series of macroeconomic disruptions, including a trade war, a pandemic, and economic instabilities caused by open conflict. These are likely to continue to be hugely disruptive to tin markets, creating increasing uncertainty about the future.

At the same time, climate change and environmental degradation are driving a global energy transition and the development of green technologies. Both of which require critical resources such as tin.

Broader sustainable development goals are rapidly changing the way that supply chains operate and collaborate, with unprecedented scrutiny of ESG performance including responsible sourcing. Technology is set for a surge that will fundamentally change the way that we live and work.

Underneath this turbulence, tin markets are growing steadily as emerging economies expand. Within these emerging economies we see improving lifestyles which will drive the demand for tin in electronics, houses, cars and convenience food.

These interrelated market forces are bringing the world into a new competitive era, focussed on resources but not yet tin.

By 2030

Geopolitical turbulence will prioritise the supply security of commodities across the board including tin and the many raw materials and components critical to tin markets. New global economic alliances will form, with dynamic and often issue-specific relations. Resource nationalisation will increasingly constrain the global availability of tin.

The Indo-Pacific will become increasingly important. Emerging economies across the globe will become new consumption centres. More than half of the world's tin-using population will be in middle classes, with 1.3 billion extra consumers. For instance, India has the world's fastest growth rate and will replace the US as the world's second largest economy based on purchasing power before 2050.

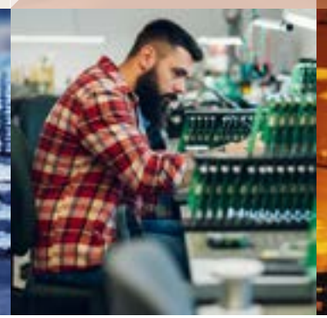
The world will work together on the UN Sustainable Development Goals (SDGs) for eradicating poverty, inequality and injustice. Market incentives for responsible production will emerge, based on credible ESG transparency, and be a focus for the tin industry.

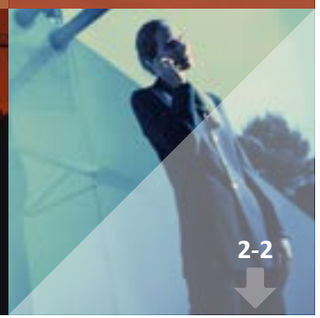
Open Questions

Will tin trading practices need to change, including long-term contracts, the role of the London Metal Exchange (LME) and the importance of tin traders?

How will downstream companies respond to potentially conflicting priorities in securing tin supply?

The geography of tin production and use will evolve radically to accommodate these trends. Supply chains will relocate, diversify and be increasingly influenced by government interventions. Existing participants will be challenged but opportunities will open for new tin players to enter the market.





SUSTAINABILITY

Securing a **sustainable** future

MAINSTREAMING ESG TRANSPARENCY

MOVING BEYOND ESG AUDITS

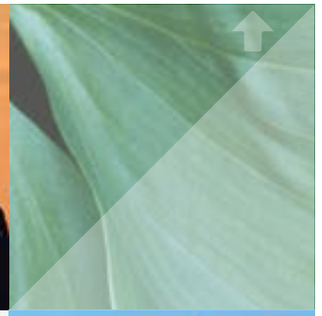
WORKING TOGETHER ON ESG ISSUES

MAINSTREAMING ESG TRANSPARENCY

Company value measured by ESG performance.

The market will differentiate companies who strive beyond minimum requirements, including those who achieve the UN 2030 Sustainable Development Goals (SDGs), presenting opportunities and challenges across the tin supply chain.





Where we are

Tin has opportunities to expand in existing and new markets including through the global energy transition. To seize the opportunities the industry must demonstrate vision and commitment to continually improve ESG performance and contribute to the UN 2030 SDGs.

The tin industry has to intensify efforts towards better practices and maximum transparency in ESG disclosure across the value chain. All companies are now expected to report across broader 'E, 'S' and G' indicators in both onshore and offshore production including carbon emissions, water, biodiversity, conflict, human rights, communities, diversity and inclusion, gender, legal compliance, anti-bribery, and corruption.

Non-financial reporting regulations, including in the EU and Asia, are pushing companies towards mandatory due diligence. Beyond regulation, downstream users and investors are using ESG reporting to manage reputational risks from mining and metals. All these parties are seeking differentiation in markets where ESG is a core element of business. Increased attention from NGO's and media is adding further pressure.

ITA members have taken steps to implement wider ESG reporting to demonstrate and measure progress via several mechanisms including the industry's Tin Code.

By 2030

Company value will be measured through the most credible ESG criteria with new market incentives and penalties embedded in purchasing policies. All actors in the value chain will be required to maintain and improve their ESG performance and reporting.

Significantly expanded reporting demands will result in an excess of ESG information that will challenge understanding. Innovations in data visualisation and/or company scorecards potentially supported by relevant technology may present new opportunities for collating and filtering supply chain information. Governments and companies will face reputational risks and litigation on ESG claims and 'greenwashing'.

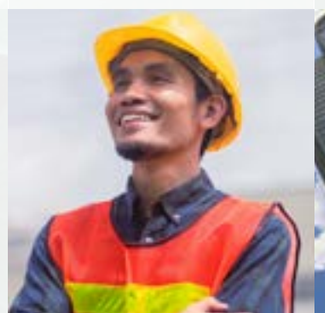
A major focus will be on reporting carbon reductions to align with net zero targets of tin users such as the steel industry. Green technologies including electric vehicles (EV) will contribute to reduced environmental impacts from mining and recycling. Growing recycling will increase scrutiny on secondary material sources. Similarly, the social and economic benefits of artisanal and small-scale mining (ASM) will become clearer.

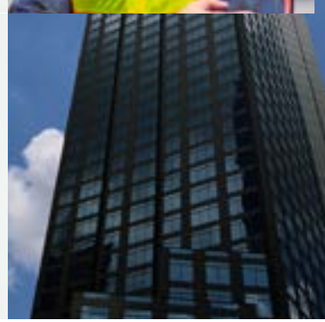
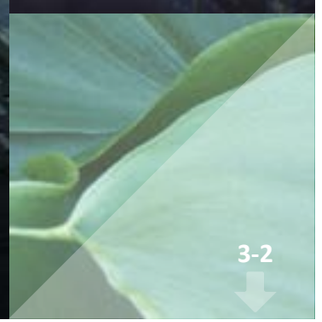
Significant coordination within the tin industry will be required to maintain realistic boundaries and move forward through new adaptations of the Tin Code.

Open Questions

How can increased demand for ESG data be managed?

How can the market recognise or reward sustainable metal with 'green premiums', paying more for sustainable and responsibly produced metal?

MOVING BEYOND ESG AUDITS

Progressive improvement assured by meaningful standards.

Regular auditing plays an important role but will be rebalanced by prioritising progressive improvement, through supply chain engagement.

Where we are

Audits based on one-off visits are commonly used to evaluate supply chains, yet they are increasingly scrutinised due to growing evidence of their limitations. Audit reports shared publicly or with customers often contain insufficient information on ongoing challenges and contextual realities. Acting as pass/fail compliance or certification, audits can struggle to adequately represent efforts on supplier engagement, training and capacity building or strengthened management systems.

Minimal audit reports and conformant lists are no longer sufficient to satisfy the growing appetite of investors, regulators, consumers and NGO's. This is leading to concerns around over-reliance on regulation and audit loopholes, and an audit's limited effectiveness in achieving change.

Engagement throughout supply chains to understand risks and achieve progressive improvement has been core in human rights due diligence. This continual and proactive approach is becoming more common for wider ESG supply chain risks, with remediation of negative impacts now part of the agenda.

By 2030

In the context of multiple ESG risks, actions will be prioritised on key issues. Alternatives to audits such as independent monitoring in tin producing areas will grow. They will help secure a license to operate in host communities working with local government and civil society to secure supply. Validation of efforts on remediation will be important.

New and overlapping ESG standards including those by external actors will continue to emerge. Tin's challenge will be to maintain a meaningful approach and avoid diverging standards that prompt a 'race to the bottom'. While one-off auditing will retain a role, concerns over audit quality will have to be addressed.

Validation of ESG claims using credible standards, evaluations and measures of progress will create new business opportunities for market incentives such as 'green premiums' and reduce allegations of green-washing. Additional standards led by metal associations will be in place to verify claims around recycling and science-based targets on carbon reporting.

Tin Code ratings already based on progressive improvement will be further supported by ITA endorsed ISAE 3000 assurance and will continue to provide a common standard for the global tin sector.

Open Questions

How can a global divergence of supply chain standards be avoided?

Company efforts will move beyond auditing. It will become good practice for customers to adopt more robust improvement approaches directly with suppliers.

WORKING TOGETHER ON ESG ISSUES

A holistic approach to managing risks.

A new momentum for more direct communication and collaboration between the upstream and downstream ends of the supply chain.

Where we are

Tin is seeing strong demand driven by the energy transition. Mineral supplies are increasingly being sought from existing and new higher risk areas, and the industry is expected to manage potential and actual risks. Tin producers cannot achieve this alone. Supplier and customer engagement needs to ramp up to enhance mutual understanding, resolve ESG issues, fund activities and ensure a stable market.

ITA has led responsible sourcing of tin from conflict-affected and high-risk areas (CAHRA) and encouraged early ESG reporting. Yet, tin's outdated labelling as a 'conflict mineral' is misaligned with expectations that focus on ESG progress to drive wider sustainable development and there is much more to do.

Regulators and tin users may be disconnected from local knowledge and have a remote view of risks and realities faced by tin producers. Other organisations are devising their own rankings of production risks, often with poor data.

Limited or inaccurate information may be presented to companies and investors negatively affecting the industry reputation. This can lead to harmful derisking from production areas and Artisanal and Small-Scale Mining (ASM), compromising miners livelihoods and security of supply. Enhanced company transparency on performance beyond auditing, balanced against confidentiality, is vital to build trust.

By 2030

The supply chain will face increasing challenges from changing geopolitics, sanctions, corruption, and disputes between competitors or external stakeholders. Supply chain actors will be motivated to find more direct ways of communicating and collaborating to manage risks and leverage positive contributions. Better understanding and engagement with ASM will increase business opportunities and rewards.

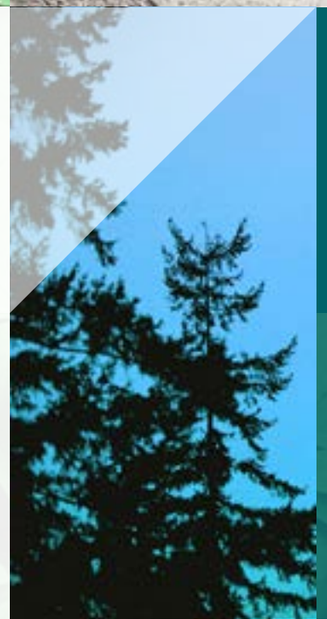
Metal associations will play a critical role in building a holistic understanding of risks including information on local context. Associations such as ITA will facilitate upstream-downstream connections, communication with all stakeholders, and taking direct action. OECD aligned industry led initiatives such as the ITSCI programme for responsible mineral supply chains will help companies remain engaged in higher risk areas.

On the ground activities that contribute to local development will increase the demand for funding of better practices. Challenges in reflecting the costs of ESG investment in tin market pricing could remain difficult to resolve, limiting progress.

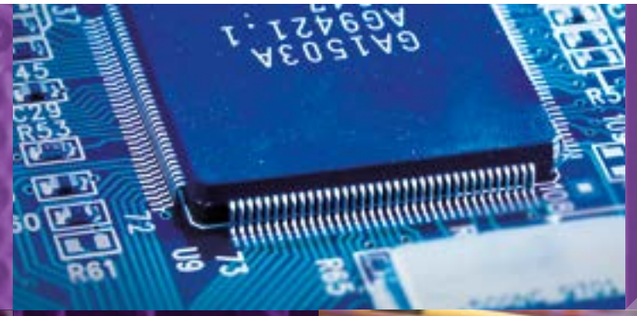
Open Questions

How can upstream-downstream communication be best facilitated by metal associations?

In what ways can market value of ESG improvement activities upstream, be costed into and distributed fairly throughout the supply chain?



Companies will need to consider all ESG impacts holistically, including broader human rights, impacts on the environment and livelihoods.



TECHNOLOGY

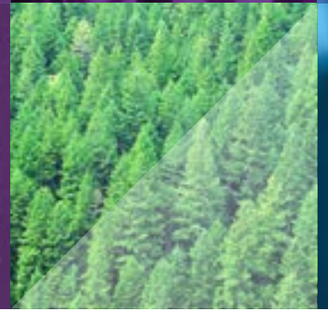
A **technology** revolution

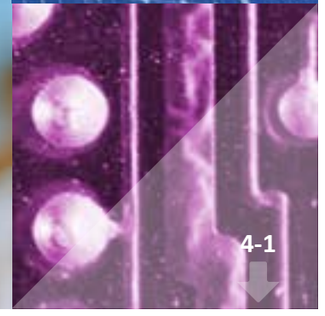
DIGITISATION

ENERGY TRANSITION

SUSTAINABLE TECHNOLOGIES

SUBSTITUTION





DIGITISATION

Tin surfs the data wave.

A fusion of machines, biology and data managed by Artificial Intelligence (AI) will merge in all aspects of modern life to create an interconnected digital datasphere. Tin will be the glue that holds it all together.

Where we are

Most of us already use interconnected smart devices including smart home devices with voice or mobile app commands to control home security, thermostats, lights or interconnected media systems.

We use personalised digital platforms that know us well to do shopping, watch films, buy insurance or choose a holiday. Wearable devices measure our health and fitness.

Industry is already using robotics and the Internet of Things to speed up manufacturing, services and logistics.

By 2030

The 'digital decade' ahead will transform the way we live, work and play by building new generations of interconnected digital devices on a 5G-based wireless communications infrastructure.

Data from physical machines, human bodies, objects and biospheres will be collected and processed in immense cloud computing platforms, to create a world shaped by AI.

Smart wearables and sensor implants will send more of your body's data into fitness and well-being apps. Smart doctors will monitor your medical condition and adjust your medication and health remotely. Smart factories, warehouses and robots will transform the world of manual labour.

AI in smart cities will continuously monitor air pollution, traffic and people flows, energy use, temperature and weather. Agricultural robots will plough and water our fields and pick our fruit.

Digital Twins will create virtual replicas of machine designs, buildings, mine sites or even supply chains so that they can be optimised by AI instead of real and often expensive people.

Much progress will be made by 2030, but decades of evolution will remain. In addition, energy use and privacy regulation may be constraints.

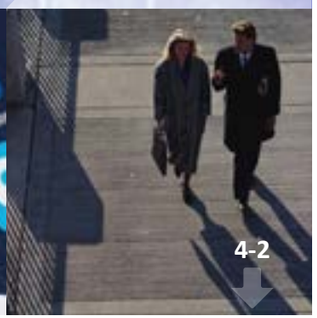
Tin will benefit in multiple ways. It will be part of the new 5G infrastructures, both in electronics and electrical components. A huge number of new electronic devices with sensors, robotics and onboard computing will all need tin as solder. There are real questions about how much computer storage will need to be built using tin, as data traffic is set to increase by ten times.

Open Questions

How much will global macroeconomic events hold back digitisation?

How can AI be used to improve efficiency in tin production and use supply chains?

Semiconductor demand is set to grow at 7% CAGR to 2030. At this scale tin demand will be immensely boosted by the end of the decade.



ENERGY TRANSITION

Climate change brings new opportunities for tin.

Rising global temperatures make the switch to renewable energy a global emergency. Tin use in solar and other energy technologies will make a vital contribution to a decarbonised future.

Where we are

Solar technologies are starting to bring a substantial new use for tin, with huge new capacity announcements. Solar cells are connected together with 'solar ribbon', a copper ribbon coated with solder. Tin is also used in copper electrical connections and power electronics.

Electric vehicles are a second source of increased tin demand, as fossil fuel use is phased out. The number of electronic components and tinned electrical connectors increase. Power electronics systems and charging stations also boost solder use.

Critical decisions on the energy transition will need to be made in the next two to three years to keep global warming well below 2°C.

By 2030

Without substantial new government intervention, by 2030 most countries will experience extreme temperature heatwaves every other year that would only have been seen once a century in pre-industrial times. Wildfires, floods, and droughts are expected to worsen.

The transition to renewable energy will be urgent but geopolitical disruptions to the energy mix will make it complex.

Solar ribbon markets will be the largest new use for tin. Smaller extra amounts of tin will be used in solar cell materials themselves, probably invisibly coated onto architectural glass.

The auto sector is already important for tin, using more than 30,000 tpa. As cars become more computerised the growth rate for electronics use is impressive. Up to one in ten vehicles could be driving themselves by 2030. More than 30% of vehicles sold will be electric, ramping up fast from less than 10% today.

At this scale of growth, we will need to store 20 times as much energy in 2030 as we do today. Tin may contribute here too. For example, lithium-ion batteries are in the forefront today but already sodium-ion and multiple other second-generation concepts are approaching commercialisation. Tin technologies will take some market share.

Multiple other smaller volume high-value markets will start to open for specialist tin products including heat energy harvesting, hydrogen generation, fuel cells and carbon capture catalysts.

Open Questions

How many of the many tin energy technologies now in R&D will make it to market?

Will there be enough tin to support government ambitions on climate change?

Around 20,000 tonnes of tin were used for solar ribbon in 2022, set to grow at 14% CAGR to 2030.

SUSTAINABLE TECHNOLOGIES

Green technologies for tin supply chains.

ESG requirements will drive innovative technology solutions to clean up pollution, eliminate waste and enable recycling. Tin producers and users will explore new technologies to reduce energy and water use, including new extraction chemistries.

Where we are

Governments and companies are already investing huge amounts in R&D to improve ESG ratings using a range of new technologies. Innovation will be an important route for mining and smelting operations, as well as downstream industries, to demonstrate a commitment to sustainable development.

At the same time R&D over the last decade has explored tin-related technology solutions to reduce processing energy, enable tin recovery from waste and protect the environment.

By 2030

Reducing energy use, and especially fossil fuels, will become an urgent priority due to climate change, rising costs and expanding markets for carbon credits.

Electrification with renewable energy will be an important factor, pointing for example towards increased use of autonomous EVs in mines and new furnace designs for smaller-scale smelters.

Digitisation will bring efficiency savings for transportation and processing that will result in lower carbon footprint.

Energy use and emissions in smelting processes will come under scrutiny, with other industries exploring radical ideas such as direct reduction with hydrogen or increased use of hydrometallurgies.

Sustainable chemistries that bypass smelting altogether by producing tin chemicals direct from ore will become possible. Some of these will borrow from tailings treatment technology or R&D on processing complex ores.

Low energy crushing technologies could also make a significant contribution. These use a propellor to generate a resonance frequency or an electrical pulse to shatter rock rather than crush it.

Technologies are also a key enabler for increased recycling, especially those that can recover tin from e-waste.

Reducing water use will also be a priority, as will clean-up and remediation technologies for mine water.

Water treatment technologies will in fact be a growing market for tin. Tin ions are an effective reducing agent for chromium and other toxic pollutants and can be used for effective clean-up of municipal water. Tin chemicals also degrade and capture organic pollutants from water using sunlight.

Open Questions

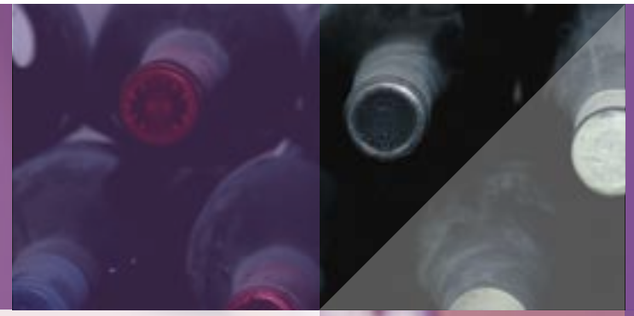
Which technologies should be prioritised?

How can the costs and risks associated with such innovation be shared across the tin industry?

SUBSTITUTION

Tin use proves mostly resistant to price pressure.

Tin will prove largely robust under increasing substitution pressure. As with all technology metals its unique technical abilities will continue to be mostly unrivalled.



Tin will continue demonstrating its remarkable properties.

Where we are

Known as the 'spice metal' tin is invisibly embedded in every aspect of modern life. From gluing together electronics, to making window glass flat, it is hard to imagine life without tin.

However, all technology metals are coming under increased scrutiny on price and availability. Diversification or substitution are obvious routes to decrease risk.

By 2030

More than half of tin has been used as solder to join copper and other metals together for decades and it is unlikely that this will change over the next decade. Often, 'solderless' technologies have been heralded but, in the end, proved too expensive or only applicable to niche electronics sectors.

There are few other low melting point metals, that can react with copper surfaces and cool to form joints with precisely the right strength, ductility and conductivity. Only tin alloys can do that and do it economically at the 200,000 tpa scale.

Substitution of tin-using products in some segments is in any case likely for reasons other than cost or regulation. For example, a switch away from brass to aluminium car radiators, or from copper pipes towards plastic plumbing. Similarly, lithium-ion batteries will likely substitute some lead-acid batteries.

Chemical uses will be more susceptible to regulation and in some cases price. In PVC stabilisers, cheaper calcium-zinc variants have taken some share, especially in Europe. 'Tin-free' polymer catalysts are also sometimes announced. There may be counter-opportunities, for example in replacement of lead stabilisers in China.

Other price vulnerable sectors are in luxury goods such as wine capsules, or pewter giftware, or in low-cost sectors such as brake pads where alternatives do exist.

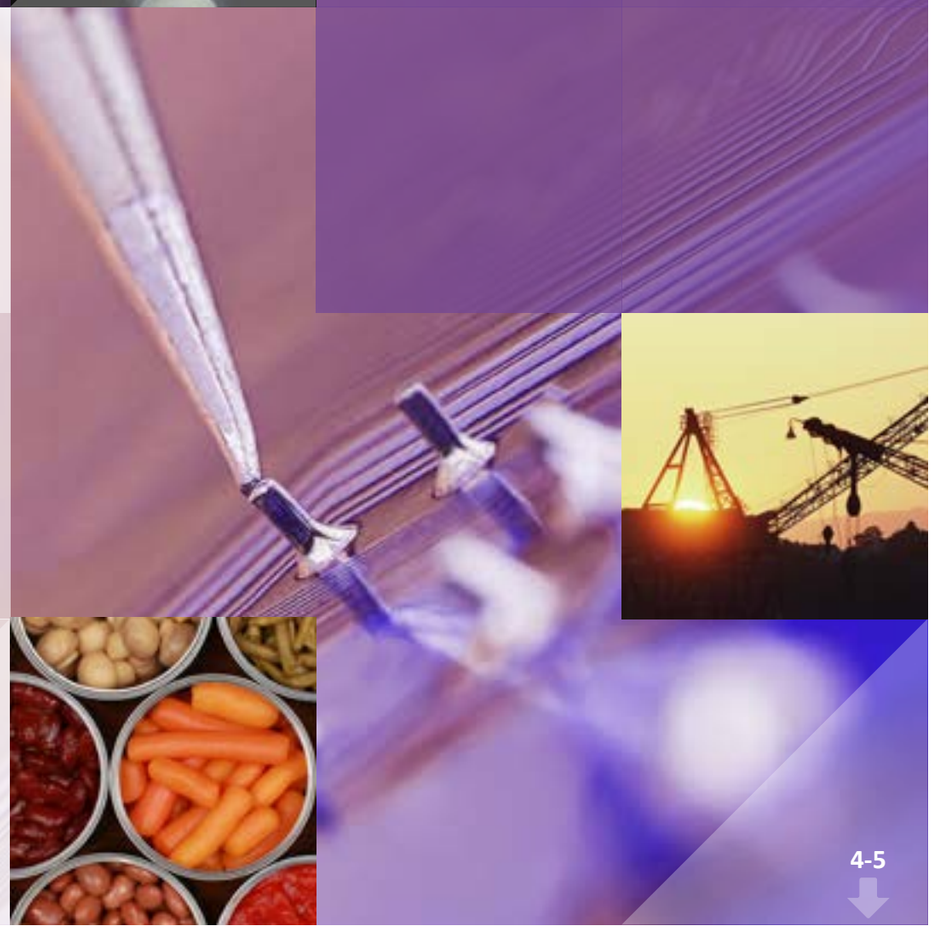
Tinplate food cans are facing some challenge from plastic laminated steel, but the market is still nascent.

Potential new uses in high tech energy technologies are likely to also be led by technical merit. In any case tin will be a relatively small component in high value products.

Open Questions

Will there be unforeseen technology breakthroughs for competitive alternatives?

Is continued pressure on lead products a threat or an opportunity for tin?



MARKETS

A **wake-up** for tin

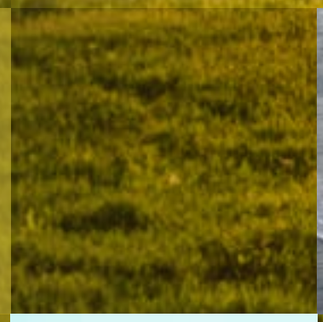
NEW INVESTMENT

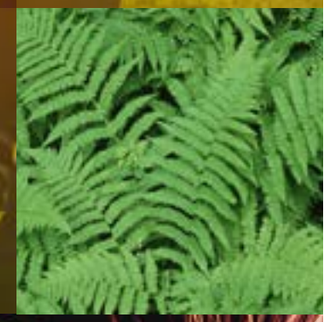
NEW RESOURCES

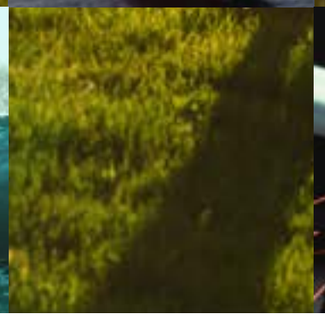
NEW SMELTING CAPACITY

INCREASED RECYCLING








NEW INVESTMENT

Investors will discover a new interest in tin.

The importance of tin in achieving global goals for climate change and technology transition will finally be realised. A new wave of investment, supported by governments, will revive and secure tin supply over the decade.

Where we are

Tin has flown under the radar for many years, leading to low investment in new supply. There have been just a handful of active new mines over the last twenty years, just one of which was a greenfield project.

Tin is still the 'forgotten' element, especially as a 'technology' metal. Although tin has begun to appear on critical materials lists around the world, it is common to see little or no supporting information.

Global macroeconomic dynamics are making it inevitable that the world will wake up to the significance of tin within the next decade. At least 50,000 tpa more tin is needed for the technology surge to 2030, with more than $1 billion extra investment required to fill the gap.

By 2030

A new investment wave will take place within a turbulent and competitive landscape. New public and private collaborations are possible, probably with government support. Smart Mineral Enterprise Development frameworks may support a more collaborative strategic approach to managing global supply and demand.

Rolling out this expansion will be challenged by significant constraints that will take more than a decade to resolve.

China, the US, and Europe all have significant undeveloped resources, but have been held back by government resistance to mining in general, as well as social sensitivities to specific areas. Policy makers will need to review the short-term impact of mining against the long-term benefits of low-carbon technologies.

Increasing production from "neutral" territories will likely be at the forefront of many governments' thinking. Sourcing metal will consider carbon emissions from production and transport. Scaling up operations in Africa and South America are likely over the next decade.

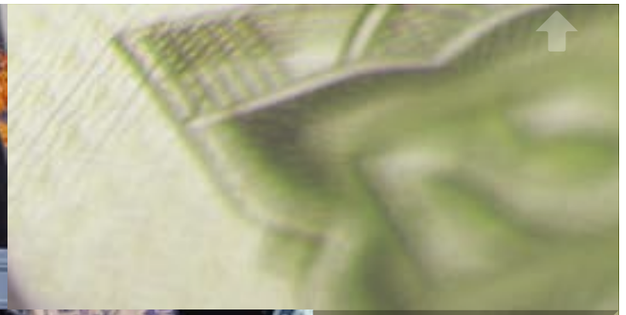
New supply-demand regional partnerships may emerge including US-South America, Europe-Africa, Southeast Asia-Australia and India-Central/South Asia.

Technology R&D programs, supported by aims to improve circular economies, will look at ways to optimise processing recoveries, minimising waste, and energy use.

Open Questions

How can the industry raise awareness of how vital tin is to climate challenges and digitisation?

Will there be enough opportunities to satisfy new competing trade and technology interests?

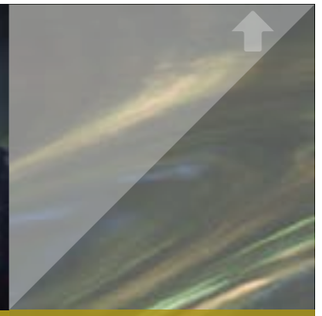


Few realise that solder used for all electronics interconnection is actually tin.

NEW RESOURCES

Legacy projects re-evaluated.

Looming deficits and geopolitical concerns will renew the search for new tin projects. Previously disregarded tin resources will be re-evaluated in the current economic and technological environment.



Where we are

Known tin resources could sustain the market for more than 50 years if exploited, and there is likely much more that is unknown today. The next decade will see a new evaluation of how this potential can be viably unlocked in time to keep shortfalls to a minimum.

Supply from existing mines will be stable or in decline at current levels of investment and exploration. Costs are increasing and grades are declining. On the other hand, there is a substantial portfolio of new mine prospects and a recent upturn in exploration for new tin projects.

By 2030

Although some existing tin resources have been thoroughly studied, there are still many areas that have seen minimal investigation. Central and Southeast Asia, including India, have many deposits identified by geologists. Russia is one of the most prospective countries for tin and has recorded the most JORC-compliant resources.

Modern exploration techniques have only been applied to small areas, with significant tin deposits potentially undiscovered by cruder methods. European and US production has been mainly based around recycling, but deposits exist that have not been re-evaluated in the current technological and economic environment.

Some ASM may provide an economic route to buffer rapid market growth for deposits that would not be of interest for large-scale mining.

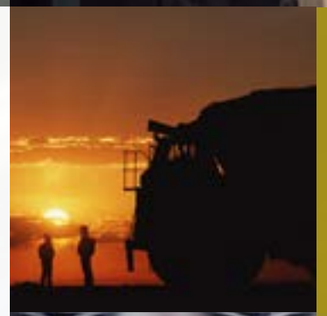
Projects that had been shelved or closed at lower tin prices may be reconsidered in light of increasing prices and better mining and processing technology. Existing infrastructure and geological datasets will lower start-up costs and reduce lead times.

Tin discarded into tailings due to small grain sizes, low grades, or poor processing recovery could be another potential source of tin. Benefitting from low cost, rapid development, and environmental benefits, tailings reprocessing projects will gain popularity.

Open Questions

What kind of economic and geopolitical environments would be necessary to support boosted investment in new tin supply?

Are there sufficient skills available within the tin industry to support such a quantum leap in exploration?



Re-assessment of tin as a co-product at existing mines and new projects may also help to fill the supply gap. Lithium and other base metals associated with tin are experiencing a supply boom and this may encourage new supply.

NEW SMELTING CAPACITY

A diversified tin smelting industry.

Geopolitical and environmental demands will require tin smelter diversification, particularly in key consumer regions.

Where we are

Currently, most tin smelters are integrated operations, producing both tin and downstream products. There are relatively few smelters that purchase or toll smelt tin concentrates. These smelters are located in just three countries, all in Asia: China, Malaysia, and Thailand.

Global pressures on supply chains are likely to challenge this restriction.

Customers are already becoming less willing to purchase metal that has been shipped the equivalent of once around the globe. Mines are often closer to the consumer than the smelters, particularly for European customers.

Reliance on just a few sources, and even fewer shipping routes, resulted in widespread supply challenges in 2020. Companies are looking to spread risk amongst a variety of producers from around the world.

By 2030

This issue will likely result in new smelters in key regions, closer to customers and sourcing from more local mines. Conversations are already beginning in Europe.

Refined tin is also a more attractive investment prospect and more acceptable as collateral for bank loans. The metal is traded on global exchanges, meaning that producers are less susceptible to traders' whims and there is always a market. Most prospective tin mines will likely give some consideration to building smelting capacity.

Some large consumers may choose to invest in their own mining and smelting capacity to completely disengage from any supply chain risk – a conversation that has already started in other metals such as nickel.

At the same time, an increasing interest in localised recycling will incentivise co-processing of tin waste, some sourced from customers in return for tin units. Some technological limitations will need to be explored.

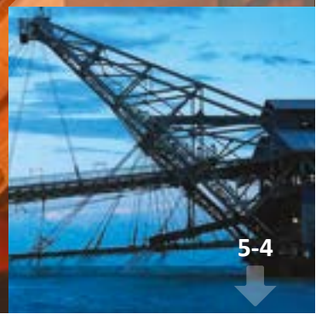
New facilities will likely focus on low emission, carbon efficient technologies using more renewable energy.

However, challenges remain as tin smelting is a low margin business and needs scale. Technology improvements could help to improve revenue. Cooperative projects may improve viability and share risk. More diversified smelting units could open to reduce exposure to price fluctuations in individual metals.

Open Questions

Will governments be sufficiently incentivised not only to permit but to encourage new smelters?

What technical capabilities would be needed and where would they come from?



INCREASED RECYCLING

Secondary tin supply will be a priority.

Circular economy trends and industry needs will combine to continue boosting tin recycling. Technology will unlock new potential, but feedstock availability will be a constraint and there will be more ESG scrutiny.

Where we are

Consumer-backed brand pressure to increase the use of recycled materials has been gathering pace, supported by regulations and decarbonisation. More recently, looming technology metal deficits and resource nationalisation concerns have added additional impetus. However, this is putting the spotlight on ESG issues with new demands for standards and proof of secondary source.

Today secondary production is based on recycling of production waste from solder and chemical uses like electroplating, with end-of-life inputs such as detinning tinplate cans and e-waste. Recycling alloys from lead-acid batteries and bronzes makes up the other half of the tin recycling loop.

By 2030

Increased government focus on critical materials and circular economies will have unlocked some of the technological, economic and logistical barriers for tin, with availability the key driver.

The UN SDG on responsible consumption will drive increased recycling but customers and regulators will examine ESG performance and supply risks.

End of Life recycling has much potential, especially tin recovery from e-waste. Tin content of up to 3% in a circuit board will likely attract a growing interest.

Collection and dismantling of e-waste within countries and regions will be streamlined to ensure that more circuit boards are made available for recycling.

Extensive R&D has already laid out possible pathways towards increased tin recovery from waste circuit boards and these will become more mainstream.

Tin-copper feedstock volumes will grow strongly as new markets in solar ribbon, electrical infrastructure, and electric vehicles begin to reach end-of-life.

Significant amounts of tin could also be recovered from battery waste slags at secondary lead smelters. These are complex with very low tin content, but the next decade may bring a wave of new technologies that could be applied.

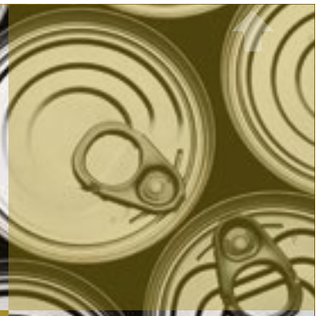
Detinning of tinplate will be another focus area, based on new faster chemistries and better logistical design of can collection routes.

Increased PVC recycling may also liberate some tin additive by-products.

Open Questions

What will be the limits of feedstock availabilities?

How can lower tin content feedstocks such as tinplate be economically processed at scale?



Technology breakthroughs and macroeconomic drivers will boost the long-term Recycling Input Rate for tin of around 30%.

TIN2030
A Vision for Tin

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