Introduction to high-tech metals

NSW GOVERNMENT

What are high-tech metals?

High-tech metals are those metals that support the rapidly growing high-technology industries, which are fuelled by consumer demand for a high-tech, environmentally sustainable future. High-tech metals are often very expensive as they may be hard to find, difficult to extract in economic quantities, or have unique properties that make them difficult to substitute with lower cost metals.

New South Wales has a very proud exploration and mining heritage, due to having significant endowment, world-class mineral systems and stable governance. NSW is a world-class exploration destination for traditional commodities such as gold, copper, and base metals, with world-class mines such as Cadia. For example, since commercial production commenced in 1999, Cadia has produced over 9 million ounces (>255 000 kilograms) of gold. In fact, approximately 1000 tonnes (t) of gold and 4 million tonnes (Mt) of copper have historically been produced in NSW.

NSW also provides exciting opportunities for high-tech metals. There are many highly prospective areas, some buried at shallow to moderate depths, which have undergone very little exploration.

The high-tech metals that NSW currently produces, or has the potential to produce include:

- copper and gold
- rare earth elements (REEs), including scandium
- platinum group elements (PGEs)
- cobalt, lithium, titanium, zirconium.

The periodic table of elements

1 H HYDROGEN																	2 He HELIUM
3 Li LITHIUM	4 Be BERYLLIUM											5 B BORON	6 C CARBON	7 N NITROGEN	8 O OXYGEN	9 F FLUORINE	10 Ne NEON
11 Na SODIUM	12 Mg MAGNESIUM											13 Al ALUMINIUM	14 Si SILICON	15 P PHOSPHORUS	16 S SULFUR	17 Cl CHLORINE	18 Ar ARGON
19 K POTASSIUM	20 Ca CALCIUM	21 Sc SCANDIUM	22 Ti TITANIUM	23 V VANADIUM	24 Cr CHROMIUM	25 Mn MANGANESE	26 Fe IRON	27 Co COBALT	28 Ni NICKEL	29 Cu COPPER	30 Zn ZINC	31 Ga GALLIUM	32 Ge GERMANIUM	33 As ARSENIC	34 Se SELENIUM	35 Br BROMINE	36 Kr KRYPTON
37 Rb RUBIDIUM	38 Sr STRONTIUM	39 Y YTTRIUM	40 Zr ZIRCONIUM	41 Nb NIOBIUM	42 Mo MOLYBDENUM	43 Tc TECHNETIUM	44 Ru RUTHENIUM	45 Rh RHODIUM	46 Pd PALLADIUM	47 Ag SILVER	48 Cd CADMIUM	49 In INDIUM	50 Sn TIN	51 Sb ANTIMONY	52 Te TELLURIUM	53 I IODINE	54 Xe XENON
55 Cs CAESIUM	56 Ba BARIUM	57–71 *	72 Hf HAFNIUM	73 Ta TANTALUM	74 W TUNGSTEN	75 Re RHENIUM	76 Os OSMIUM	77 Ir IRIDIUM	78 Pt PLATINUM	79 Au GOLD	80 Hg MERCURY	81 Tl THALLIUM	82 Pb LEAD	83 Bi BISMUTH	84 Po POLONIUM	85 At ASTATINE	86 Rn RADON
87 Fr FRANCIUM	88 Ra RADIUM	89–103 **	104 Rf RUTHERFORDIUM	105 Db DUBNIUM	106 Sg SEABORGIUM	107 Bh BOHRIUM	108 Hs HASSIUM	109 Mt MEITNERIUM	110 Ds DARMSTADTIUM	111 Rg ROENTGENIUM	112 Cn COPERNICIUM	113 Nh NIHONIUM	114 Fl FLEROVIUM	115 Mc MOSCOVIUM	116 Lv LIVERMORIUM	117 Ts TENNESSINE	118 Og OGANESSON

* LANTHANIDES	57 La LANTHANUM	58 Ce CERIUM	59 Pr PRASEODYMIUM	60 Nd NEODYMIUM	61 Pm PROMETHIUM	62 Sm SAMARIUM	63 Eu EUROPIUM	64 Gd GADOLINIUM	65 Tb TERBIUM	66 Dy DYSPROSIUM	67 Ho HOLMIUM	68 Er ERBIUM	69 Tm THULIUM	70 Yb YTTERBIUM	71 Lu LUTETIUM
** ACTINIDES	89 Ac ACTINIUM	90 Th THORIUM	91 Pa PROTACTINIUM	92 U URANIUM	93 Np NEPTUNIUM	94 Pu PLUTONIUM	95 Am AMERICIUM	96 Cm CURIUM	97 Bk BERKELIUM	98 Cf CALIFORNIUM	99 Es EINSTEINIUM	100 Fm FERMIUM	101 Md MENDELEVIUM	102 No NOBELIUM	103 Lr LAWRENCIUM

Key: ATOMIC NUMBER / Symbol / NAME

The high-tech world needs metals

In the past 20 years, the world has seen the emergence and rapid growth of high-tech applications in industries such as:

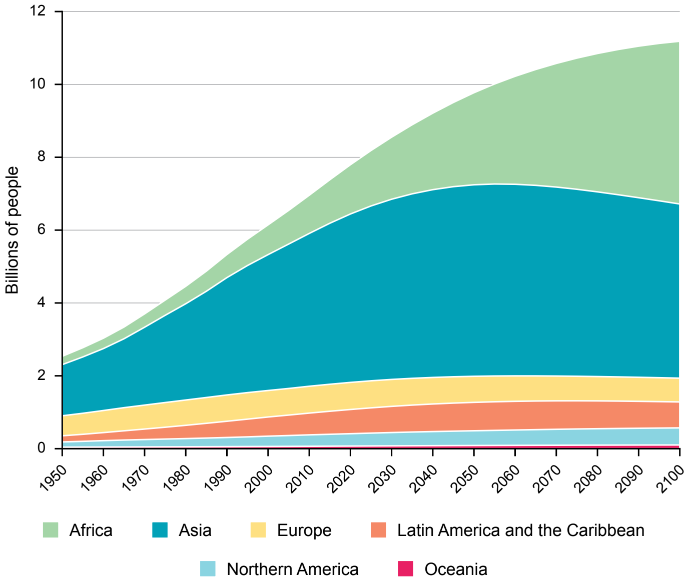
- consumer electronics (mobile phones, tablets)
- transportation (electric vehicles and advanced, fuel-efficient aircraft)
- aerospace (satellites)
- renewable energy (solar technologies, wind turbines and battery power storage).

Increased demand for advanced technology is driven by the growth in world population, in particular the emerging middle class in Asia, and the need for environmental sustainability. However, this increased demand also creates challenges in the production and supply of the high-tech metals required for manufacture of these products.

Global middle class

Since the mid-1800s, the middle class has been a consumer class, driving the economies of countries that embraced the Industrial Revolution. It ushered in an age of mass development that swept the Western world in the 20th century and is now spreading to emerging economies, especially in Asia and Latin America.

Total population by region



Today, growth of the middle class across the world is one of the primary forces sustaining the global economy. At the end of 2016, the global middle class numbered about 3.2 billion people who spent $US35 trillion. This spending is forecast to reach $US64 trillion by 2030, accounting for roughly one-third of the global economy (Kharas 2017). This increase in spending will drive demand for consumer electronics, as well as services including tourism, entertainment, health, education and transport.

Environmental sustainability

Population growth and modernisation have led to increased global concerns about pollution, carbon emissions and climate change. These concerns are shaping government policies and the development of new technologies for cleaner energy and transportation.

Renewable energy and storage

As wind and solar power have an intermittent supply, large-capacity grid storage batteries, such as those recently installed in South Australia and planned for Victoria, will be essential if clean energy generation and distribution is to dominate future electricity supply.

The Australian government has identified energy storage as a key to supporting an electricity system that is affordable, reliable and able to contribute to national emissions-reduction targets.

Electric vehicles

A recent International Energy Agency (IEA) report stated that electric vehicles (EVs) will be the basis of future sustainable transport systems.

The transition to electric road transport technologies is gaining momentum. In 2016 the number of electric vehicles doubled on the previous year, surpassing 2 million units. In the next 10 to 20 years, as the electric car market transitions from early deployment to mass market adoption, the number of electric cars is forecast to be between 9 and 20 million by 2020, and up to 70 million by 2025 (Organisation for Economic Co-operation and Development/IEA 2017).

The potential contribution of EVs towards the reduction of global carbon dioxide (CO_2) emissions could be substantial, but it will come with challenges, such as the need to increase vehicle travel range and to build the infrastructure required for charging. As demand for EVs grows, so will demand for high-tech metals such as lithium and cobalt, which are required by current and future battery technologies, and copper. With many high-tech metals facing supply challenges, battery reuse and material recycling will become increasingly important for EVs to be economically and environmentally sustainable.

Aviation

The International Air Transport Association (IATA) expects 7.2 billion air passengers to travel in 2035, nearly doubling the 3.8 billion who flew in 2016. However, this increase may result in commercial aviation being one of the fastest-growing sources of greenhouse gas emissions, with direct emissions from aviation currently accounting for about 2% of global CO_2 emissions (International Civil Aviation Organization (ICAO) 2016).

In 2013, the global aviation sector recognised the need to address the global challenge of climate change and adopted a set of ambitious targets to reduce CO_2 emissions from air transport (ICAO 2016):

- improve fuel efficiency by 2% per year until 2050
- cap net aviation CO_2 emissions at the 2020 level (carbon-neutral growth).

The achievement of these goals will require technological innovation in aerodynamics, propulsion, and light-weight materials technologies. This innovation won't be possible without high-tech metals such as lithium and scandium. These strong, lightweight metals are used to create aluminium alloys with improved strength, toughness and corrosion resistance in aerospace components.

Supply challenges

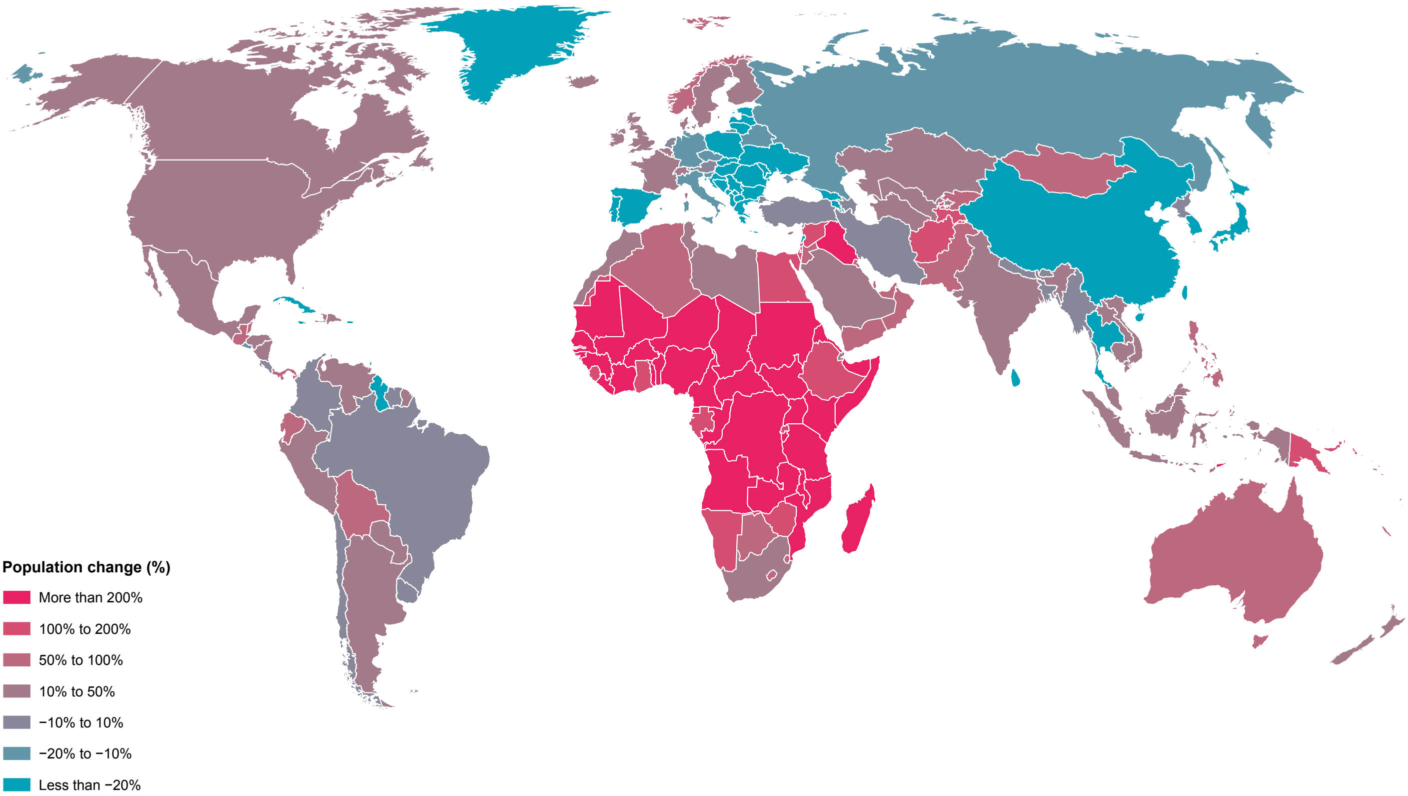
The increased global demand for high-tech metals creates serious supply challenges, including:

- scarcity of supply – many of these metals are rare, hard to find, and difficult or expensive to extract
- concentration of supply – some of these metals are sourced almost solely from one country (e.g. REEs from China and PGEs from South Africa), potentially leading to monopolies, market manipulation and volatility, and supply chain risks
- non-ethical supply – human rights organisations are demanding that companies secure their raw materials from ethical mining sources due to concerns over child labour and non-sustainable mining practices.

To overcome these challenges and increase the certainty of supply, some of the leading global car and battery manufacturers are starting to negotiate directly with mining companies for supply of their materials, and have bought shares in mines or new mine projects in order to secure a future supply from ethical sources.

A recent example in NSW is the strategic partnership between Cobalt Blue Holdings and LG Corporation, based around the Thackaringa joint venture cobalt project, to provide high-purity, battery-grade, cobalt sulphate required to produce lithium-ion batteries.

Projected population growth 2015–2100



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