Rare Earths

Rare earths are in increasing demand worldwide for use in many modern technological devices such as electric motors, magnets, lasers, batteries, computer and LCD television screens, iPods, mobile phones and magnetic resonance imaging (MRI) machines. They are also essential in energy efficient technologies such as low-energy light bulbs and hybrid cars and renewable energy technologies such as wind turbines.

What are rare earths?

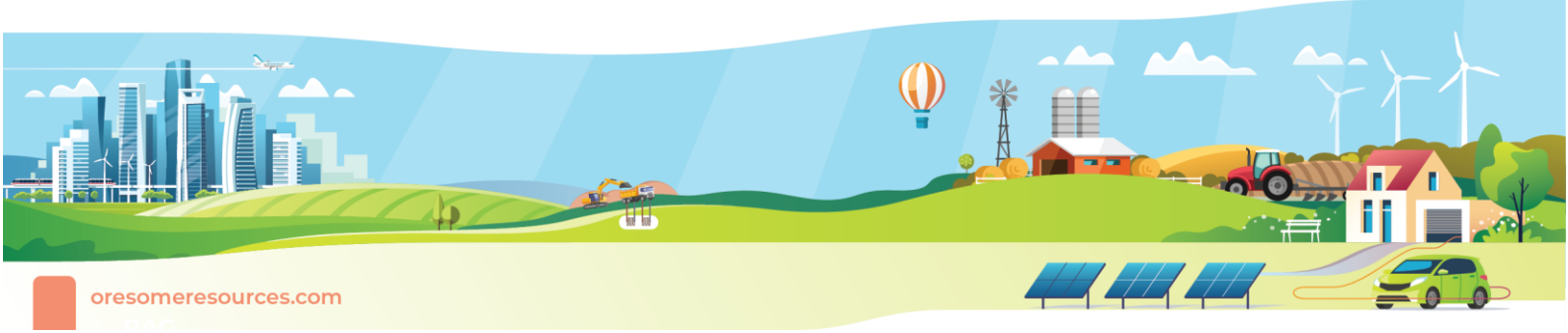
Rare earths are a collection of chemical elements. They are the lanthanide series of elements in the periodic table (atomic numbers 57 through 71) and also include yttrium (atomic number 39).

Rare earths are abundant in the earth's crust and naturally occur in close association with radioactive minerals containing thorium, uranium and other elements, but they are not radioactive.

Are rare earths mined in Australia?

Although deposits of rare earths occur in Western Australia, Northern Territory, South Australia, New South Wales and Queensland, it is uncommon to find rare earths in quantities that can be mined economically. It takes approximately 15 years to take a rare earths project from discovery to the production technology development phase through to the export of the commodity. Activities to prove up known resources are currently underway with the Mt Weld, Nolans Bore and DZP mines in Western Australia, the Northern Territory and New South Wales, respectively, due to begin operations by the middle of the decade.

Free 'Oresome Elements Ipad' App,
download from the App Store.



Rare Earths

What are the uses of rare earths?

Rare earths uses are wide ranging from high tech goods such as mobile devices and flat screen TVs to energy applications such as wind farms and hybrid cars.

They are increasingly used in the hybrid car market, a major user of rechargeable batteries (lanthanum) and high-strength magnets (neodymium). Modern hybrid cars each contain about 13 kilograms of rare earths.

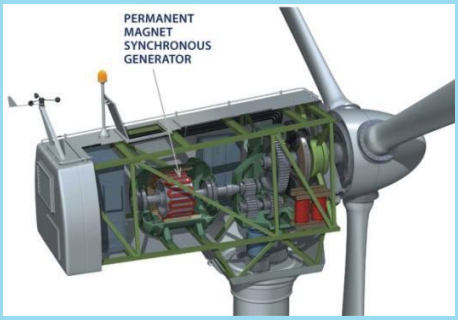
Neodymium and praseodymium are the key components for rare earths batteries used in high-tech applications such as the hybrid vehicles and wind turbines to produce clean electricity.

The key application for cerium is in the manufacture and polishing of high specification glass and electronic components. Additionally, as an additive, they improve the UV and refractive index properties of glass.

High-purity compounds of europium, terbium, gadolinium and yttrium are used in phosphors for fluorescent lighting and creating the colour in computer screens and LCD televisions.

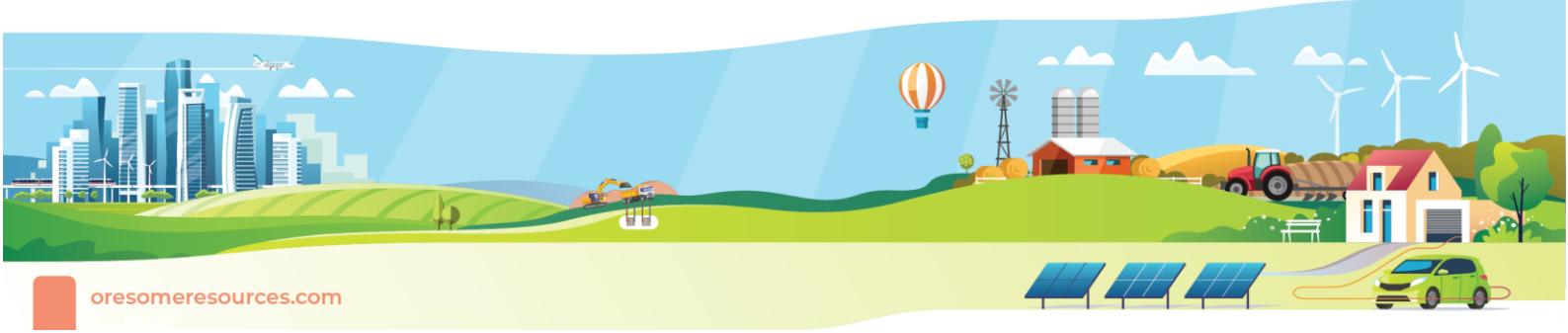
Lanthanum

Lanthanum, the lightest of the rare earths, is a silvery white metallic element. Lanthanum is used in the production of petroleum cracking catalysts used in the oil refining process. As oil demand grows more petrol is derived from heavier crude oils which uses more lanthanum. Lanthanum is also an essential component of the rechargeable nickel metal hydride (NiMH) batteries which directly power vehicles at low speeds.



Due to its refractive properties, lanthanum oxide is used to make special optical glasses, such as camera and telescope lenses. Lenses containing lanthanum tend to be used in wide angle applications such as security and mobile phone cameras.

In the phosphor market lanthanum is used to create the green colour in lighting and screens.



Cerium

The main use of cerium is to produce polishing powders for glass surfaces, mirrors and computer screens.

Cerium in various forms plays a key role in reducing vehicle emissions, in the auto catalysts in petroleum fuelled vehicles and as an additive to diesel fuels.

Cerium oxide is a powerful glass decolouriser, helping television and computer monitor producers achieve uniform colours across the globe, regardless of where screens are produced.

Cerium oxide promotes the selective absorption of ultraviolet light in a variety of components such as optical lenses, perfume bottles, some architectural glass and, increasingly, automobile glass.

In metallurgy, cerium is used to improve the creep resistance of aluminium alloys and in alloy steels as a precipitation hardening agent. Cerium is a key component of a mix of rare earth metals known as misch metal, which is a major component of ferrocerium, better known as lighter flint.

Praseodymium

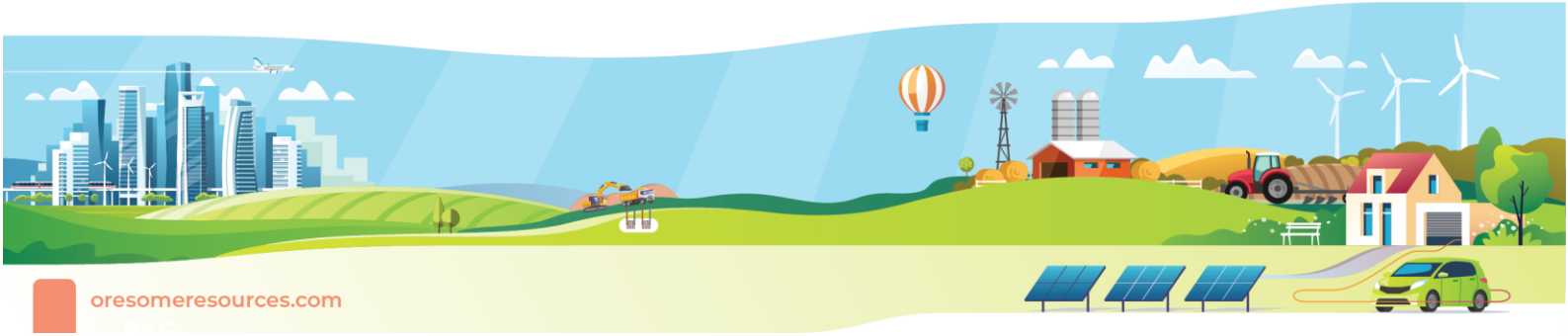
Praseodymium is the preferred yellow pigment (it is very intense) of the ceramic industries in Italy, Spain, Indonesia and China.

The main application for praseodymium is rare earth magnets. Praseodymium and neodymium are very similar chemically and hence difficult and costly to separate, so they are often separated as a mixed oxide/metal known as didymium. Praseodymium improves the corrosion resistance of rare earth magnets. Accordingly, as neodymium is in short supply, didymium is often found in rare earth magnets.

Salts of praseodymium are used to colour glasses and enamels. When mixed with certain other minerals, praseodymium produces an intense and unusually clean yellow colour in glass. Praseodymium is widely used as a core material for carbon-arcs used by the motion picture industry for studio lighting and projection.

Neodymium

The most important application for neodymium is in the manufacture of neodymium iron boron (NdFeB or Neo) magnets. Through their high strength-to-weight ratio, these magnets



have facilitated the miniaturisation of laptop computers and audiovisual recreation equipment through their use in hard disk drives and voice coils. They are also used extensively in small electric motors for the automotive industry, including starter motors, brake systems, seat adjusters and car stereo speakers. Other uses include medical magnetic resonance imaging equipment (MRIs).

Neodymium is also used as a glass and tile colouring and tinting, to produce a unique purple colour and in the production of lasers and dielectrics (electrical insulators).

Samarium

Samarium metal is used to make samarium-cobalt magnets, the first rare earth magnets to be developed more than 30 years ago. Neodymium iron boron magnets have replaced samarium cobalt magnets in most applications due to the relative scarcity of samarium and supply of cobalt. However, samarium cobalt retains its magnetic properties at much higher temperature than the neodymium alternative, hence this material is the magnet of choice in aviation applications and 'under the hood' applications in luxury and high performance vehicles.

This rare earth metal is also used to make lasers, and samarium oxide is used in optical glass to absorb infrared light.

Europium

Europium is the most reactive of the rare earth elements, oxidising instantly in air, while being as hard as lead and quite ductile.

Europium oxide is commonly used as a red phosphor in television screens, computer monitors and fluorescent lamps. The high growth in demand for computers and energy-efficient lighting has led to the demand for for this rare earth.

Europium is also used to make lasers and in the screening process for Down syndrome and some other genetic diseases.

Europium fluorescence is used to uncover evidence in drug-discovery screens and in the anti-counterfeiting phosphors in Euro banknotes.

Gadolinium

Gadolinium is a silvery white, malleable and ductile rare earth metal with a metallic lustre.

Gadolinium compounds are used for making phosphors for colour television tubes and the manufacture of compact discs and computer memory.

Gadolinium compounds possess paramagnetic properties where they do not retain any magnetism without an external magnetic source, which allows them to have a number of medical uses.

This enables these compounds to be used as intravenous radio contrast agents to enhance images taken in MRI procedures, and also in X-ray imaging.

Terbium

Terbium is primarily used in phosphors, particularly in fluorescent lamps, as the high intensity green emitter, and as an x-ray phosphor. Terbium is also used in alloys and the production of electronic devices and as a component in actuators, naval sonar systems, sensors, and other magneto-mechanical devices. When combined with europium blue phosphors and europium red phosphors, terbium is used to provide "trichromatic" lighting technology, which is by far the largest consumer of the world's terbium supply. Trichromatic lighting provides much higher light output for a given amount of electrical energy than incandescent lighting.

Dysprosium

Dysprosium is a relatively stable rare earth element with a metallic, bright silver lustre. Small additions of dysprosium to neodymium iron boron magnets, its major use, significantly improve the retention of the magnetic properties at elevated temperatures. In conjunction with vanadium, dysprosium is used

to make some specialty laser materials. As it is highly paramagnetic, dysprosium is also used as a contrast agent in MRI medical procedures.

Perth City Council House

Yttrium

Yttrium is a silver-metallic, lustrous rare earth metal that is relatively stable in air. The major use for this rare earth, in its oxide form, is in the production of yttria stabilised zirconia, a highly wear-resistant material used extensively by the mining industry.

Yttrium oxide is the largest rare earth component in the production of red phosphors for television, computers and fluorescent lights.

Yttrium aluminium garnet, created with yttrium oxide, has a hardness of 8.5 and is therefore used as the common diamond substitute, zirconia. It has been used to create white light-emitting diodes (LEDs – low voltage lights that glow instead of getting hot) used in modern dentistry and medical practices as well as other lighting and indicator displays such as those used at airports.

As the demand for fuel cells increases so will the demand for Yttria as it is an essential component of most of the solid oxide fuel cells currently under development.

The United States Geological Survey estimates world reserves of rare earths at 88 million tonnes. Of that total, Australia accounts for 5.2 million tonnes, 22m tonnes in China, 19m tonnes in the former Soviet Union and 13m tonnes in the US.

The Chamber of Mines and Energy Western Australia is acknowledged as the provider of this resource, with significant contributions from Arafura Resources Limited

All images courtesy of Arafura Resources Limited.