

Strategic Metals & Rare Earths Letter

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► **NdPr** key enabler of hybrid and electric vehicles as high-performance magnets play

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Neodymium-praseodymium oxide (NdPr) is in short supply globally and is the critical raw material in the manufacturing of ultra-strong, high-performance **NdFeB** permanent magnets, which are used extensively in the automotive industry for electric components such as seals, mirrors, wipers, steering and breaking.

Importantly, the component has also emerged as a high enabler of hybrid and electric vehicles as high-performance magnets play a key role in electric traction motors.

While traditional petrol or diesel combustion engine motor vehicles each use approximately 0.8 kg of NdPr oxide, electric car hybrid vehicles require an additional 1 kg.



The increasing shift towards hybrid and electric drivetrain technologies among the world's leading automotive manufacturers is expected to continue to positively influence market fundamentals for **NdPr**.

► **China** controls NdPr market

In December 2016, Chinese authorities announced another round of domestic rare earth supply chain as part of Beijing's ongoing effort to reduce illegal rare earth production and enforce environmental standards in the country.

In the most thorough and comprehensive review to date, the ongoing inspections have covered more than 400 companies operating in 23 provinces, with an explicit focus on 180 companies involved in mining, processing and trading of rare earth products.

The ongoing inspections follow the recent consolidation of China's rare earth enterprises into 6 large groups to centralize industry control, increasing government oversight and strengthen the pricing power of China's major rare earth producers, as evidenced by the international demand for the REE elements **neodymium** and **praseodymium**, collectively known as **NdPr**.

The rare-earth magnetics in most electric vehicles (EVs) contain 1 to 2 kilograms of NdPr per vehicle and are fundamental to the powertrain of electric vehicle motors in current models such as Nissan, LEAF, Chevrolet Bolt and BMW 13.

► Off-take agreements are thinning availability of NdPr oxide on the spot market

With the consolidation of mining and processing companies in the large groups over the past 2 years to 6 major REE oxide suppliers, including for NdPr, these suppliers are entering in long-term off-take agreements with companies of the same group, limiting the quantity of material available to the spot market.

For example, China's largest producer of NdPr oxide, China Northern Rare Earths Group (CNRE) is the committed supplier, via **Bayan Obo** to Inner Mongolia Baotou Rare Earth Magnetic Materials, which now has a capacity to produce 30,000 tonnes of NdFeB annually following consolidation.

Outside of China, **Lynas'** Weld mine in Australia, the world's second largest producer of NdPr oxide, is a contracted supplier to virtually all of Japan's major rare earth trading houses and magnets manufacturers - namely Sojitz, Daido Steel and Showa Denko – and is also supplier to Shinin Elso in Vietnam, leaving little-to-no-capacity available for the spot market.

In China, JLM Mag Rare-Earth for example, is planning to increase NdFeB production of 6,000 to 10,000 tonnes in the next 12 months, thereby increasing its allocation of NdPr output from the **Maoniuping mine** by over 60%.

As electric vehicle demand is anticipated to grow strongly and long-term off-take agreements continue thinning availability of NdPr oxide on the spot market, this may lead to continued strength in NdPr spot prices.

With higher spot prices in China, this will make the prospect of spot supply from Lynas and advanced-stage rare earth exploration economically attractive, as buyers in China can avoid paying a 17% value-added tax (VAT) imposed in China-derived supplies.

► Lynas the only producer of NdPr oxide outside China

Since 2012, **Lynas** has continuously ramped up NdPr oxide output through its Malaysian-based processing facility and driving down production costs. In the second quarter of 2017 **Lynas** reported TREO production of 4,093 tonnes of which NdPr oxide production of 1,343 tonnes, representing approximately one-third of total TREO production and post-tax operation profits of approximately US\$ 4.25 per kilogram. The company's results are expected to increase in the second half of 2017.

The value of **Lynas'** NdPr output is 83% of total output.

► Overview of NdPr exploration companies

REE exploration companies with a high share of NdPr oxide are:

Located in Canada :

Commerce Resources (Ashram project), **Matamec Resources** (Kipawa project), **Search Minerals** (Foxtrot project)

Located in Australia :

Alkane Resources (Dubbo project), **Arafura Resources** (Nolans project), **Northern Minerals** (Browns Range project).

Located in Africa :

Peak Resources (Ngulla project), **Mkango Resources** (Songwe Hill project) and **Rainbow Rare Earths** (Gakara project)

Located in Chile : **Minera BioLantanidos** (El Cabrito project)

In Greenland, the **Ilimausaq Complex** hosts the world's two largest REE deposits: **Greenland Minerals & Energy's** multi-element Kvanefjeld project and **Tanbreez'** Kringlerne project.

Market pricing

Having increased approximately 70% in the third quarter of 2017 from US\$ 45/kg to a high of US\$ 78/kg, the **NdPr** FOB China price softened to US\$ 43/kg in February due to low buying interest and plentiful inventories.

However, **NdPr** prices have strengthened to US\$ 53.75/kg, an increase of 24% in the past month, on tight spot supply in the lead up to Chinese New Year mid-February, as buyers anticipate price increases on potential Chinese Government stockpiling.

The demand for NdPr oxide is expected to grow at 8% per annum to 2025 for current global consumption of 33,340 tonnes.

