NATURAL RESOURCES AND RENEWALBE ENERGY

Minerals and Renewable Energy
Strategic Elements in Clean Technologies

XVIII Joint Meeting of the Japan-Brazil Economic Cooperation Committee

Porto Alegre-RS

August 31, 2015, Monday

Comitê de Cooperação Econômica
BRASIL-JAPÃO
JAPAN-BRAZIL
Economic Cooperation Committee

KEIDANREN

FIERGS

CNI
Confederação Nacional da Indústria
CNI. A FORÇA DO BRASIL INDÚSTRIA

IBRAM
INSTITUTO BRASILEIRO DE MINERAÇÃO

IBRAM – Brazilian Mining Association

Founded on December 10th, 1976, the Brazilian Mining Association (IBRAM) is the Country's entity that represents corporations and organizations in the mining industry. It is a private, nonprofit association with robust coordination capabilities, and it has the following objectives:

- Bring together, represent, promote, and advance the Brazilian Mining Industry in order to advocate for their interests and help boost their competitiveness;
- Collaborate with governments, including on the development of technical studies;
- Promote sustainable development and use of best practices in occupational safety and health in the Mining Industry;
- Foster studies, research, development, innovation, and use of the best technologies available.

IBRAM:

- Brings together 180 Corporations (Mining companies and other organizations);
- Represents companies that account for over 85% of Brazil's Mineral Production.

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RELATIONSHIP BETWEEN STRATEGIC MINERALS AND ENERGY SECTOR

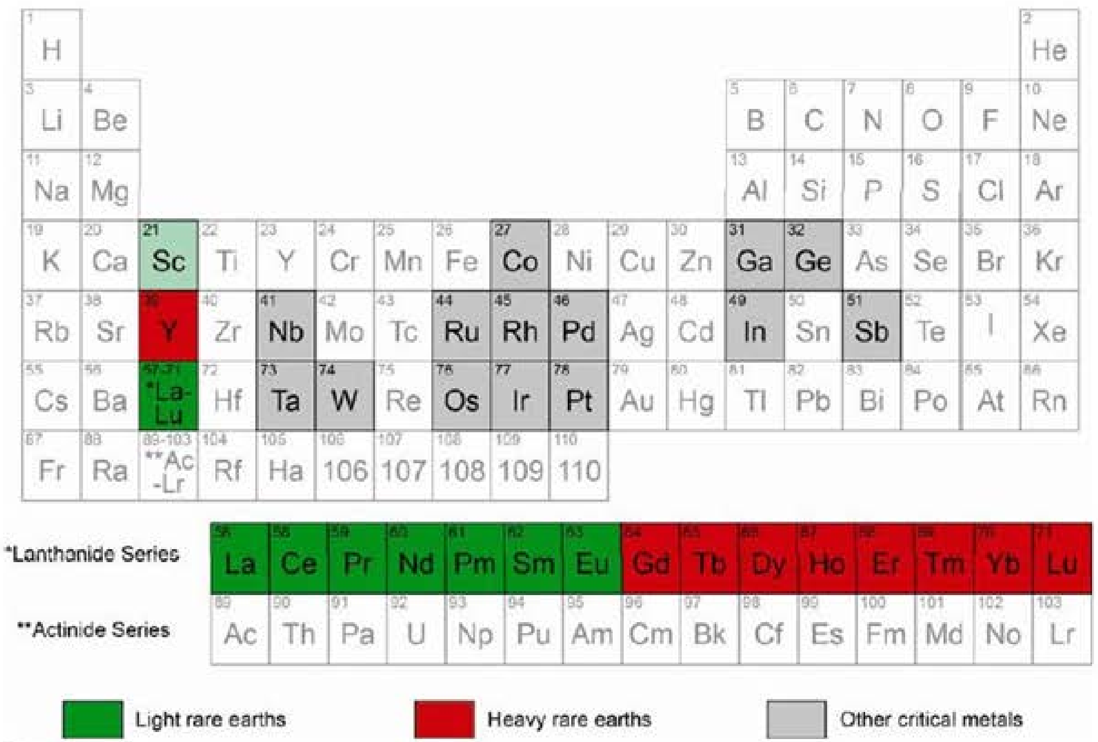
- Neodymium and dysprosium
- Graphite
- Silicon (SiO_2: Quartz / silica)
- Wind Generators / Turbines
- Permanent Magnets
- Electric car / Battery
- Photovoltaic Cells

WHAT ARE RARE EARTHS?

The so-called Rare Earth Metals or Rare Earth Elements (REE in English) are a unique group of chemicals that have electronic properties, optical, magnetic and catalytic special. They act primarily as enablers or facilitators of these properties into other elements or metals. Its use components manufactured from a wide variety of alloys and compounds can have marked effects on complex engineering systems.

The Pure Chemical International Union and Applied defines the rare earth metals as the 15 elements Lanthanides (with atomic numbers 57 to 71) with the addition of scandium (Sc) and Yttrium (Y) (Connelly et al., 2005).

- 17 chemical elements on the periodic table: the 15 lanthanides, plus scandium (Sc) and yttrium (Y)
- Average concentration crust 150-220 ppm (Cu 55 ppm, Zn 70 ppm)



Light REE
La: Lanthanum
Ce: Cerium
Pr: Praseodymium
Nd: Neodymium
Pm: Promethium
Sm: Samarium
Eu: Europium

Heavy REE

Gd: Gadolinium
Tb: Terbium
Dy: Dysprosium
Ho: Holmium
Er: Erbium
Tm: Thulium
Yb: Ytterbium
Lu: Lutetium

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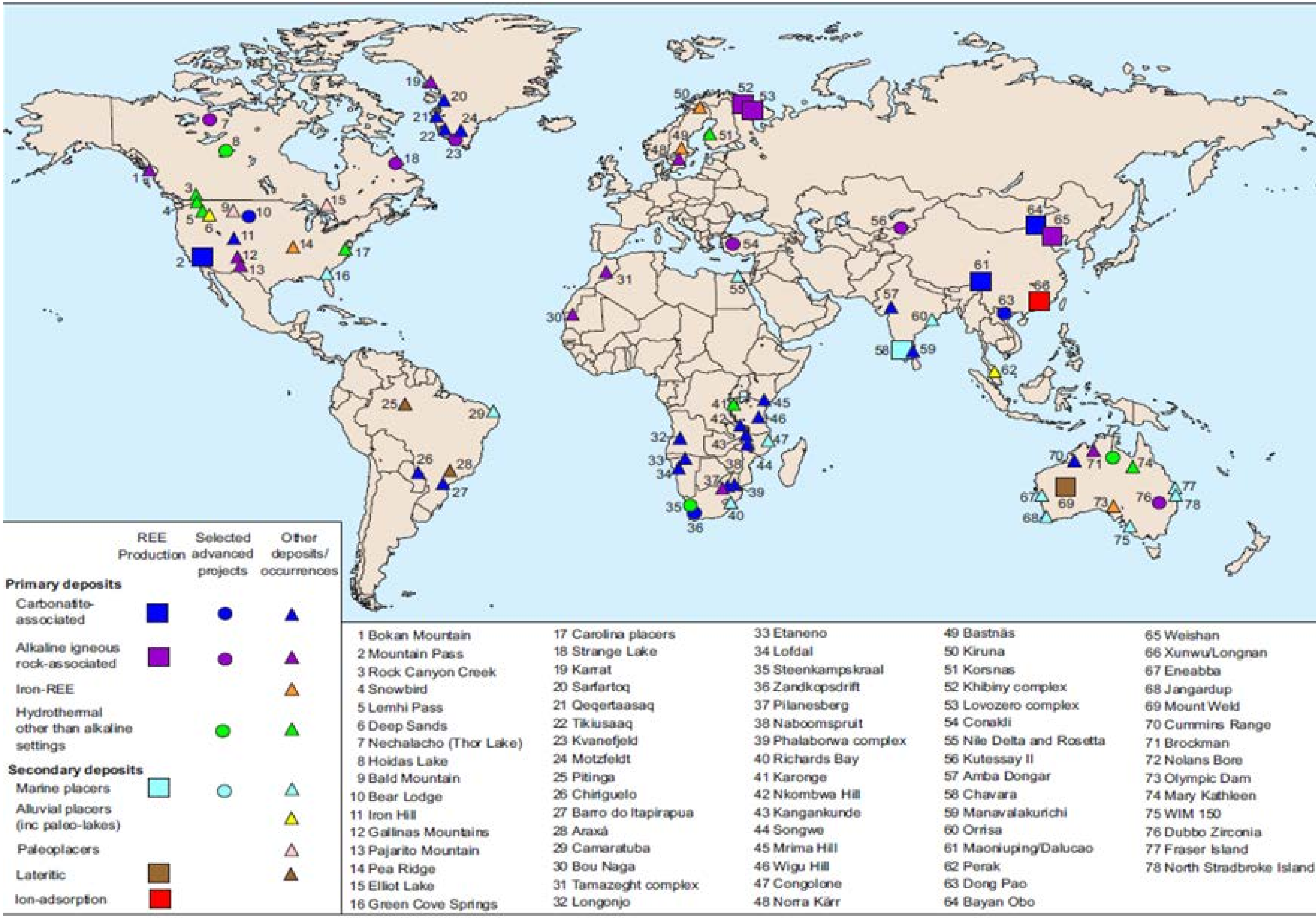
WORLD - MINES, DEPOSITS AND MAJOR OCCURRENCES OF RARE EARTHS



Source: British Geological Survey – REE Commodity Profile - 2012

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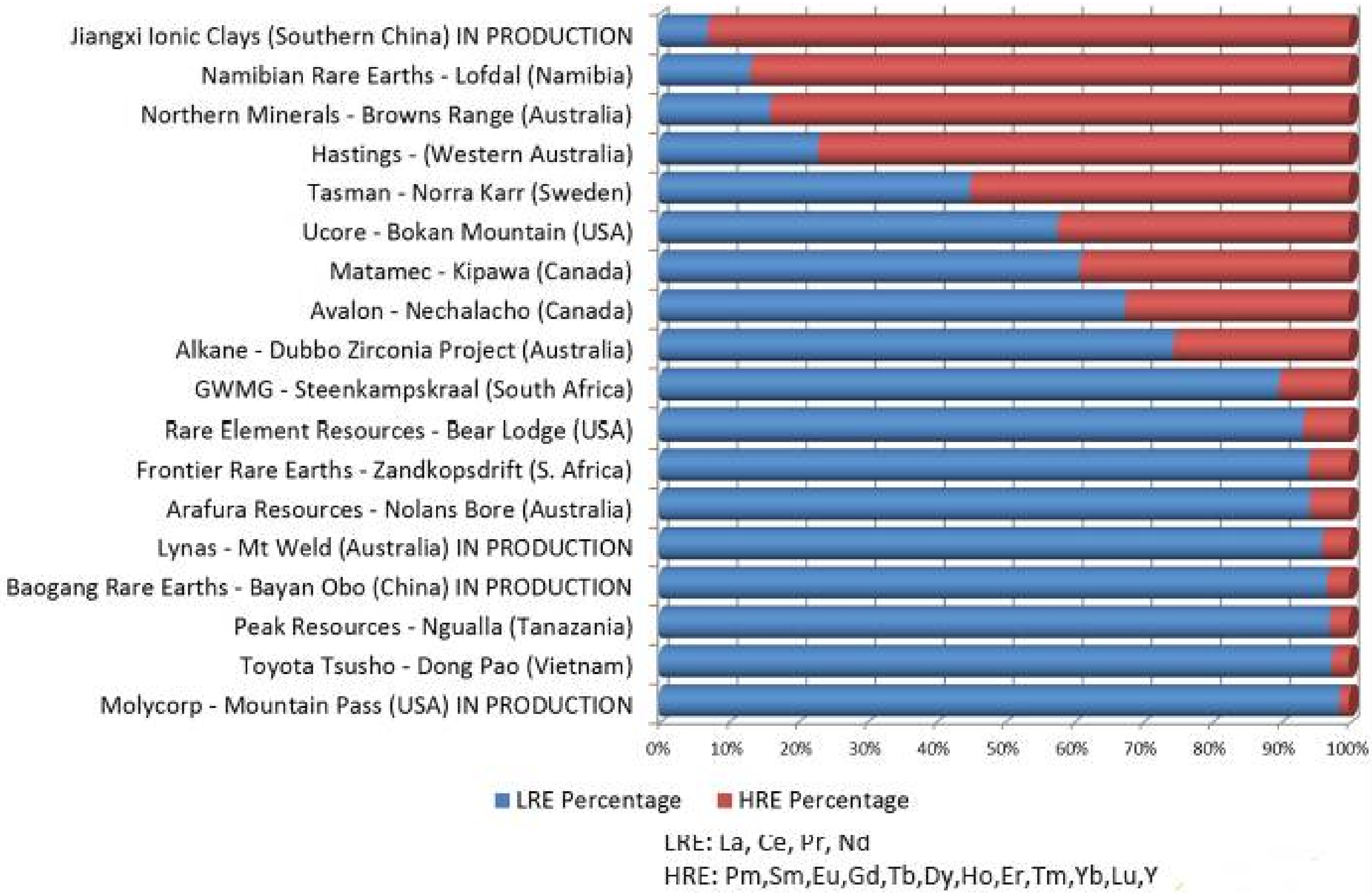
WORLD - SOME RECENT RARE EARTH PROJECTS



Source: Critical Minerals 2013, Robin Wilson of Northern Minerals Ltd, Nagrom (2013)

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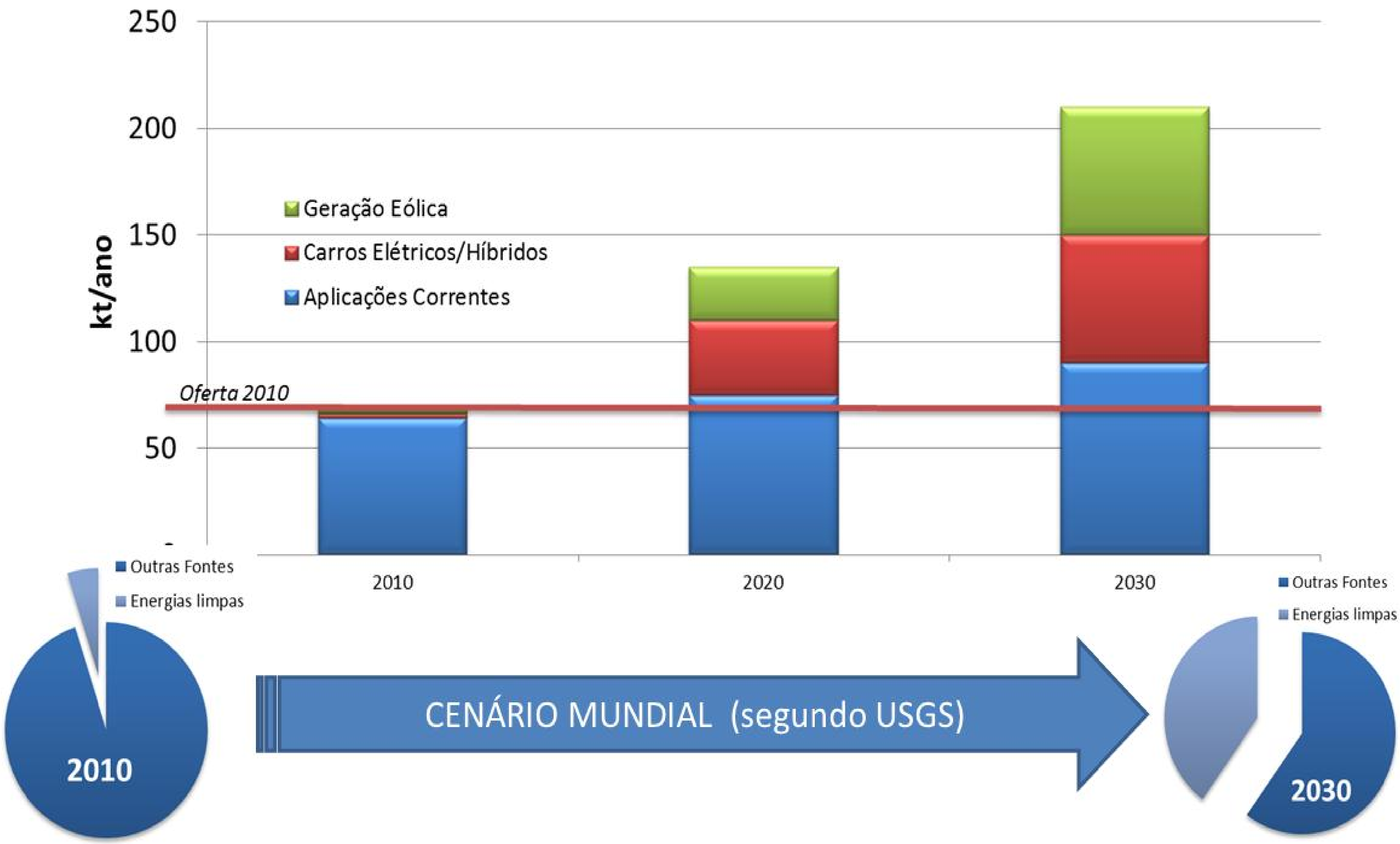
BRAZIL - MAJOR OCCURRENCES OF RARE EARTHS

MOST IMPORTANT AREAS

Source: Em Discussão – Terras Raras – Revista de Audiências Públicas do Senado Federal. Ano 4, No. 17, setembro de 2013

DEMANDS FORECAST MAGNETS REE
(WORLD DEMAND - FORECAST CONSERVATIVE)



Source: Fundação CERTI 2013

The Issue:

- **Chinese monopoly**
- **Speculative prices**
- **Snsecure supply**
- **Domain Chinese strategy**
- **Complexity for the entrepreneur**

Challenges :

- **Access raw material**
- **Solutions of S & T & I process**
- **Environmental issues**
- **Articulation of Technology, Government and Business Players**

Source: Fundação CERTI 2013

Mil e uma utilidades na alta tecnologia

MANY USES IN HIGH-TECH

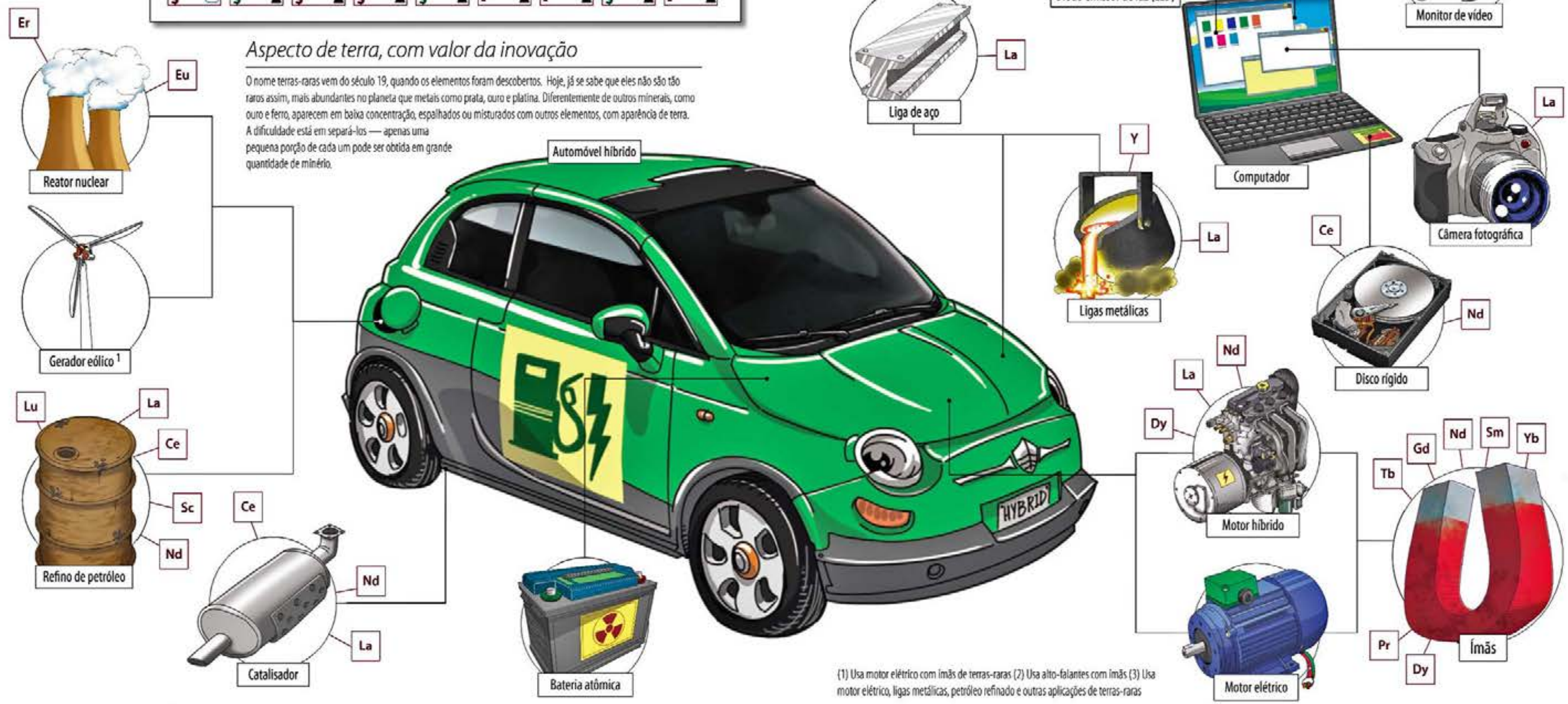
Os elementos de terras-raras têm características eletrônicas, ópticas, magnéticas e catalíticas, associadas a leveza, resistência e eficiência energética. Veja onde estão as terras-raras e em que produtos elas são aproveitadas

Nome do elemento
Símbolo na tabela periódica
Crítico: $; ou Não crítico: $
Pesado: ▲; ou Leve: ☁

Xoxoxoxo X	Escândio Sc	Ítrio Y	Lantânio La	Cério Ce	Praseodímio Pr	Neodímio Nd	Promécio Pm	Samário Sm
Európio Eu	Gadolínio Gd	Térbio Tb	Disprósio Dy	Hólmio Ho	Érbio Er	Túlio Tm	Itérbio Yb	Lutécio Lu

Aspecto de terra, com valor da inovação

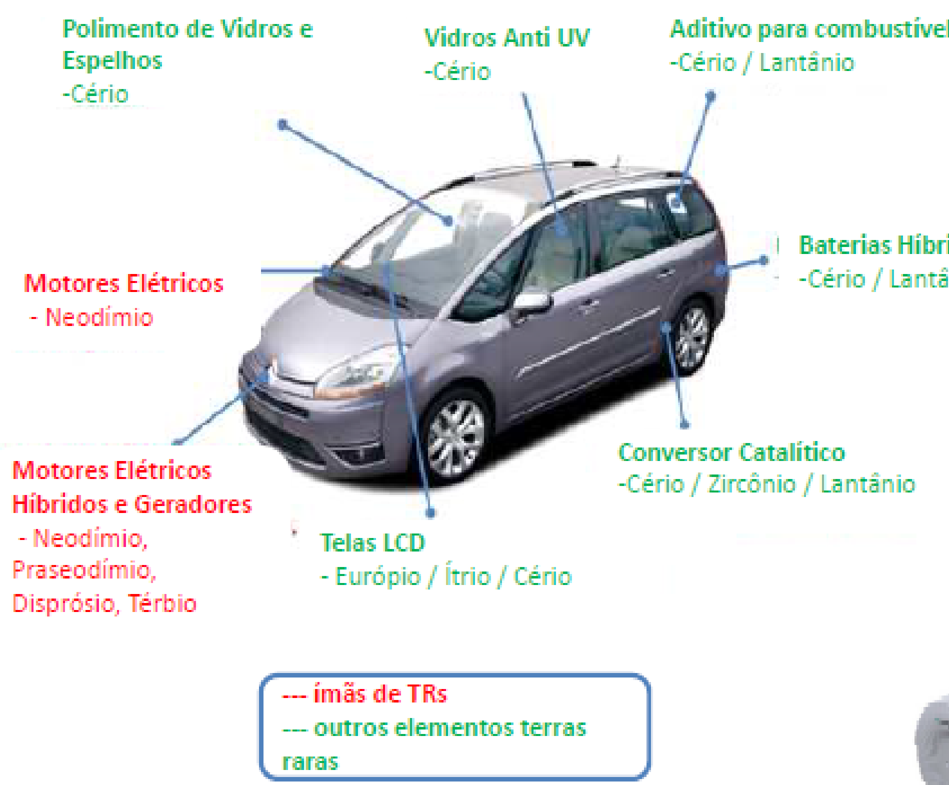
O nome terras-raras vem do século 19, quando os elementos foram descobertos. Hoje, já se sabe que eles não são tão raros assim, mais abundantes no planeta que metais como prata, ouro e platina. Diferentemente de outros minerais, como ouro e ferro, aparecem em baixa concentração, espalhados ou misturados com outros elementos, com aparência de terra. A dificuldade está em separá-los — apenas uma pequena porção de cada um pode ser obtida em grande quantidade de minério.

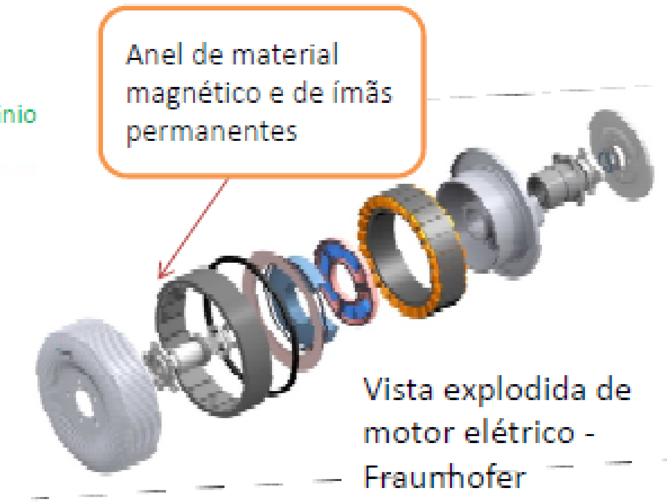


(1) Usa motor elétrico com ímãs de terras-raras (2) Usa alto-falantes com ímãs (3) Usa motor elétrico, ligas metálicas, petróleo refinado e outras aplicações de terras-raras

Outras aplicações

NEW MARKET: ELECTRIC CAR AND HYBRID





Source: Fundação CERTI 2013

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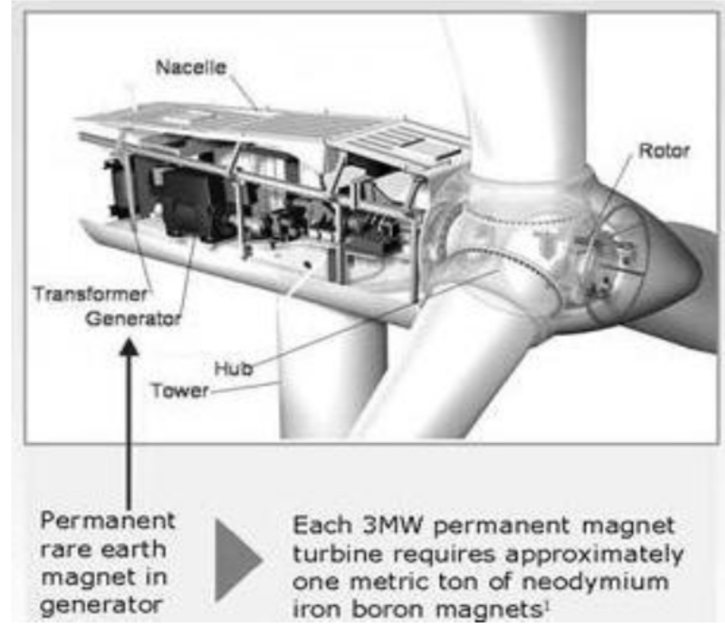
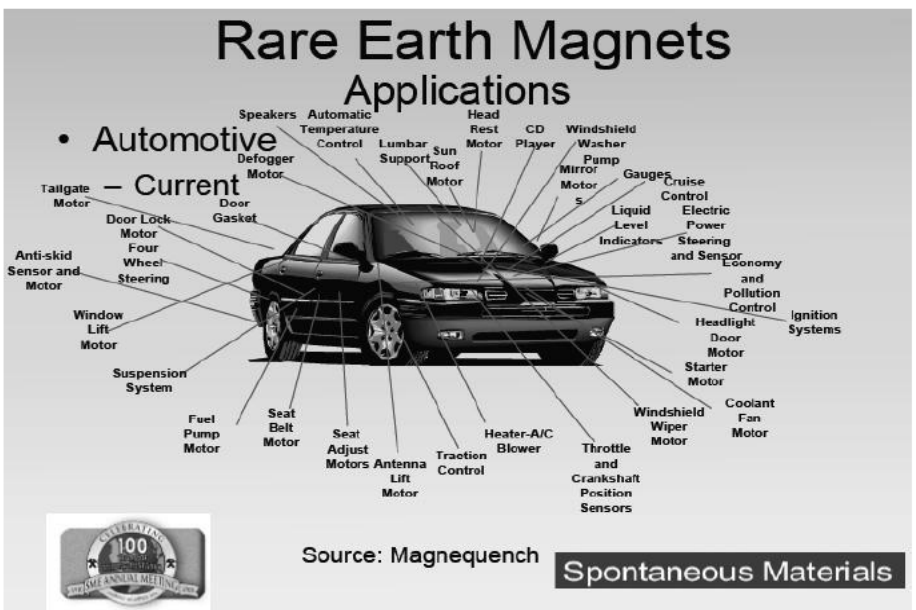
Consumption 0.6 to 1 t per magnet NdFeB
(180 to 300 kg Nd / MW wind)





For example, it is recognized that the hybrid motor of the Toyota Prius need Nd 1kg, and the Mercedes S-400 need 0.5 kg; the high durability batteries of Prius Ni-MH (Nickel Metal Hydride), require from 12 to 20 kg of La per unit

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NEW MARKET: WIND POWER

generator with gears and rotor winding

gearless generator with magnets of rare earths

400-1000 kg of NdFeB magnets by MW

Source: ENERCON

Advantages of generators with rare earth magnets:

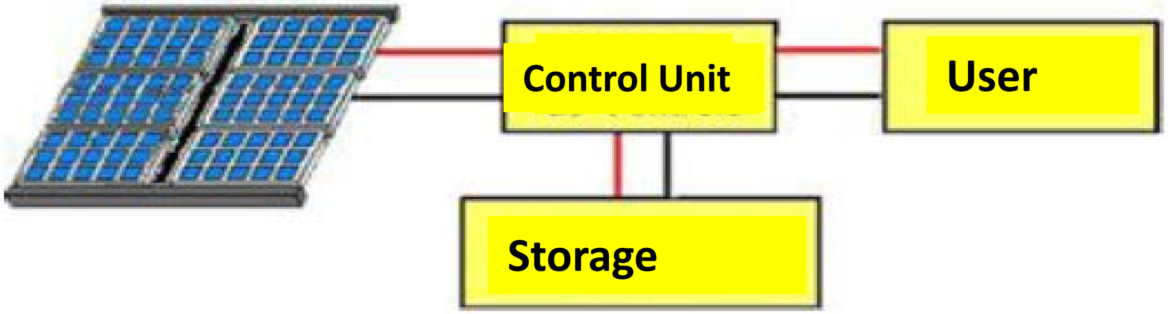
- Eliminates the need for gear boxes
- Greater energy efficiency and ratio power / weight
- No need to supply power to the excitation field
- Higher reliability due to less mechanical parts
- Cost-benefit ratio favors machines with magnets of rare earths

Source: Fundação CERTI 2013

PHOTOVOLTAIC CELLS

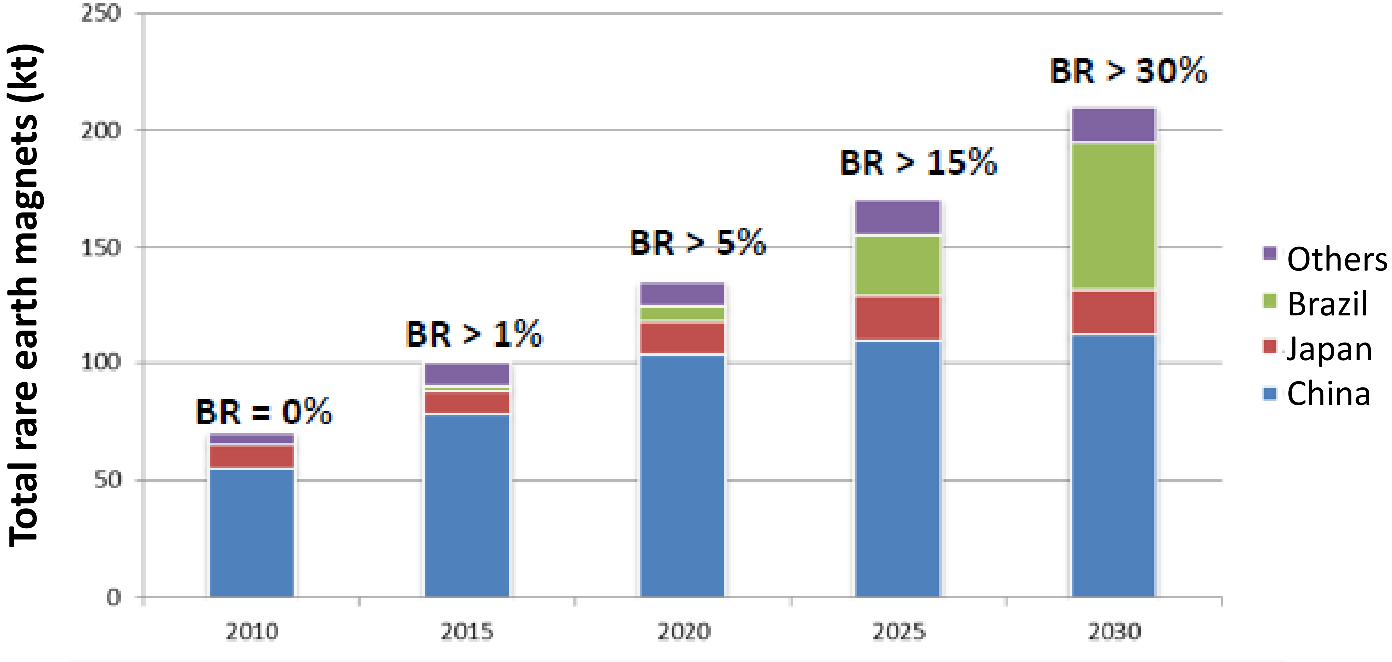
A photovoltaic system can be classified into three distinct categories:

- **Isolated system**
- **Hybrid system**
- **Networked system**



The semiconductor **crystalline silicon** of high purity operates in the direct conversion of power associated with solar radiation.

WORLD MARKET VALUE



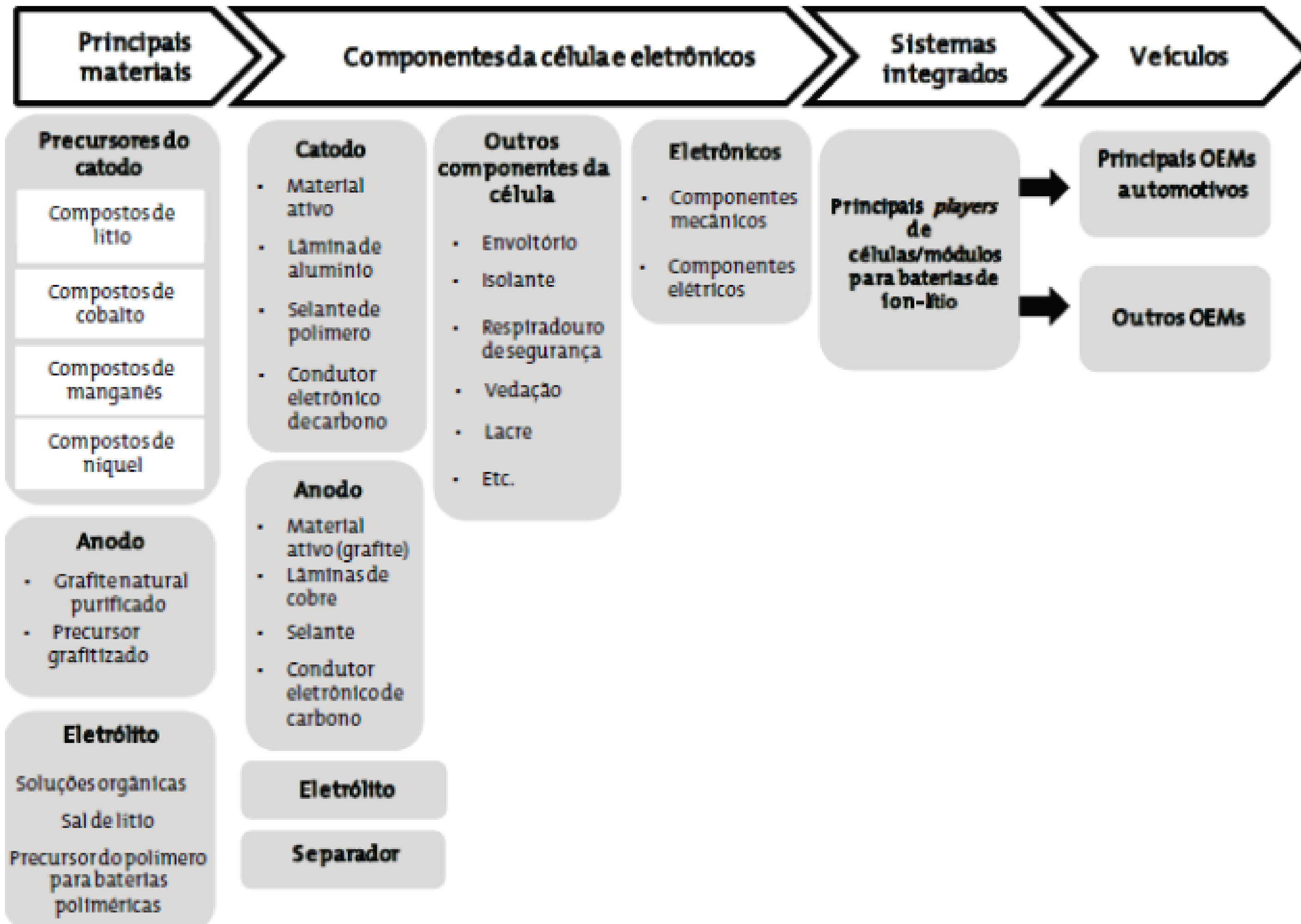
US$ 2 B

US$ 5 B

US$ 10 B

Source: Fundação CERTI 2013

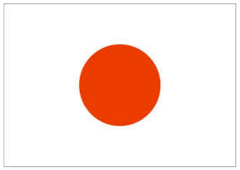
LITHIUM ION BATTERY



Source: Center on Globalization, Governance & Competitiveness da Universidade de Duke (EUA)

LITHIUM ION BATTERY

(MARKET SHARE)

In 2000		In 2008
Sanyo, Sony, Panasonic Toshiba, Nec-Tokin, Hitachi-Maxwell		Sanyo, Sony, Panasonic Hitachi-Maxwell
93,8%		48,3%
BYD		BYD, BAK, ATL
2,9%		15,9%
LG Chem, Samsung		Samsung, LG Chem
1,7%		22,4%
Others players: 1,6%		Others players: 13,4%

Source: Hawamoto, H. Trend of R&D on materials for high-power and large capacity lithium-ion batteries for vehicles applications. Science & Technology Trends, Quartely Review – July 2010

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MINISTERS CELEBRATE FIVE AGREEMENTS BETWEEN BRAZIL AND GERMANY CONCERNING ST&I

Angela Merkel during visit in Brazil with Pres. Dilma Rousseff last August 20

Under the agreement, MCTI and BMBF plan to promote research and implement sustainable technologies for the supply of rare earths and other raw materials primary and secondary economic importance; develop strategies, master plans and implementing measures together with research institutes, private companies, financial institutions and government authorities; support innovation in small and medium enterprises of the two countries and facilitate the exchange of researchers and information.

Strengthen research related to the supply of niobium, tantalum, and especially rare earths - 17 essential chemicals for the manufacture of technological items such as tablets, smartphones, MRI machines, hybrid cars, catalysts for petroleum refining and wind turbines.

Source: MCTI

16TH BRAZILIAN MINING CONGRESS

Panel – **Rare Earths and Strategic Minerals: from the potentiality to the effectiveness**

Brazil has great potential for strategic mineral reserves that could meet the growing global demand for high-tech industries. However, it still lacks an industrial policy that contemplates the implementation of solid and well-structured supply chains. Still, the growing interest from mining by the search for new deposits of strategic minerals and rare earths. In this context, the panel will discuss mainly the feasibility of a new cycle in terms of materialization of business for companies in the sector.

14:00-15:30 h on ***September 16th, 2015 - Wednesday***

http://www.exposibram.org.br/

http://www.wmc2016.org.br/

24th World Mining Congress
MINING IN A WORLD OF INNOVATION

October 18 to 21, 2016
SulAmerica Business Center
Rio de Janeiro/RJ

CALL FOR TECHNICAL PAPERS

The event focuses on "**Mining in a World of Innovation**" and brings together an exhibition space, a conference, and the presentation of technical papers. The integration of senior executives, mining professionals, and scholars, as well as important Brazilian and international investors will enable an extensive exchange of information concerning the development of mining, science, technology, economics, health and occupational safety and environmental sustainability.

TOPICS

- Mineral Exploration
- Surface Mining
- Underground Mining
- Mine Economics
- Mining Sustainability
- Mineral Processing
- Automation and Robotics
- Mining Innovation

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Thank you!

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Marcelo Ribeiro Tunes
Director of Mining Affairs

www.ibram.org.br