FUTURE DIRECTION AND CHALLENGES OF MALAYSIAN RARE EARTH INDUSTRY AS A POTENTIAL GREEN ECONOMY ENGINE

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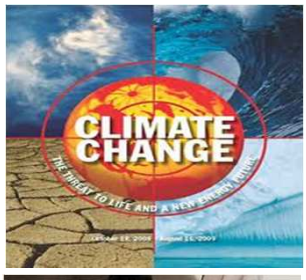
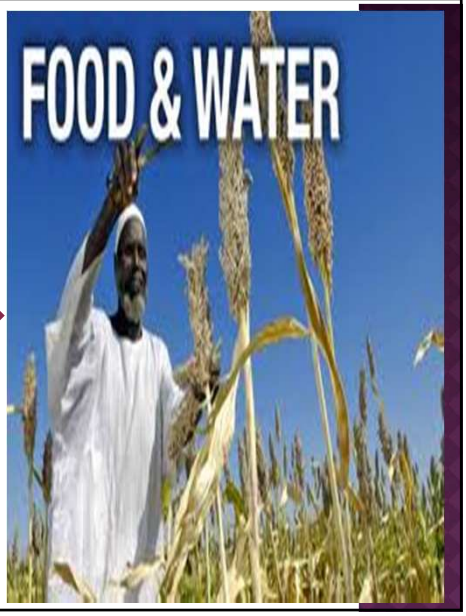
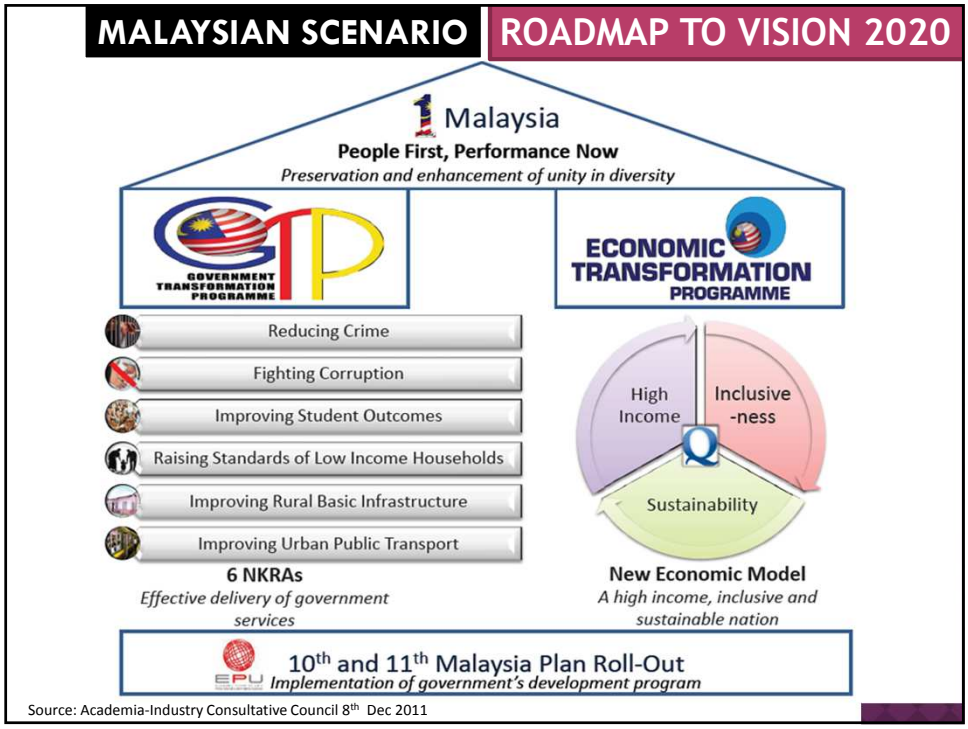
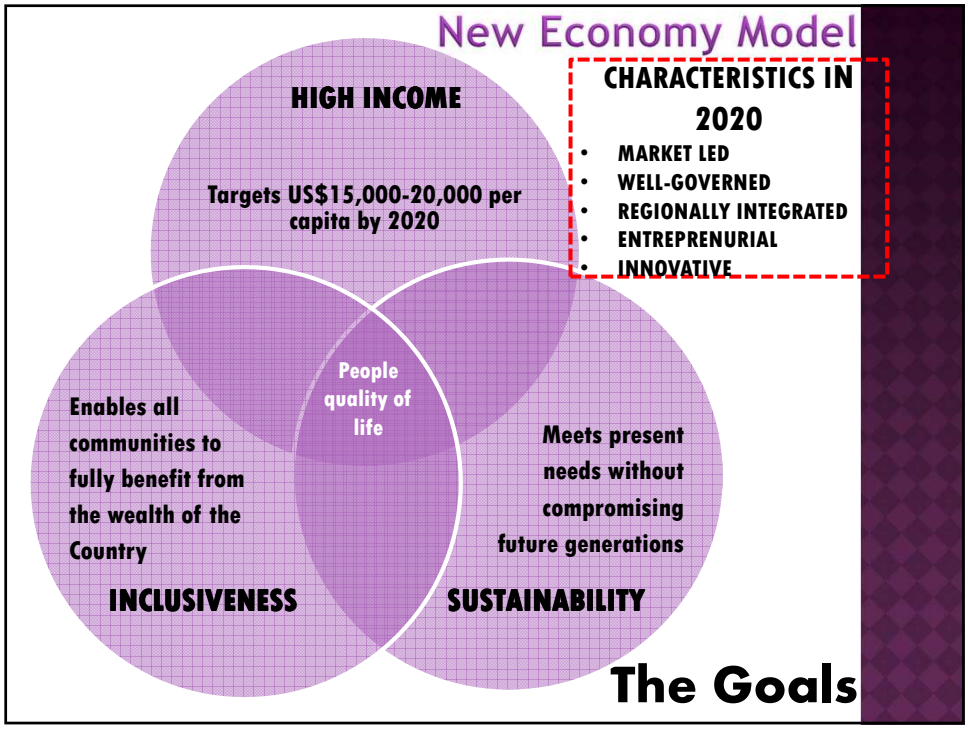
UNIVERSITI MALAYSIA PAHANG
28TH AUGUST 2013

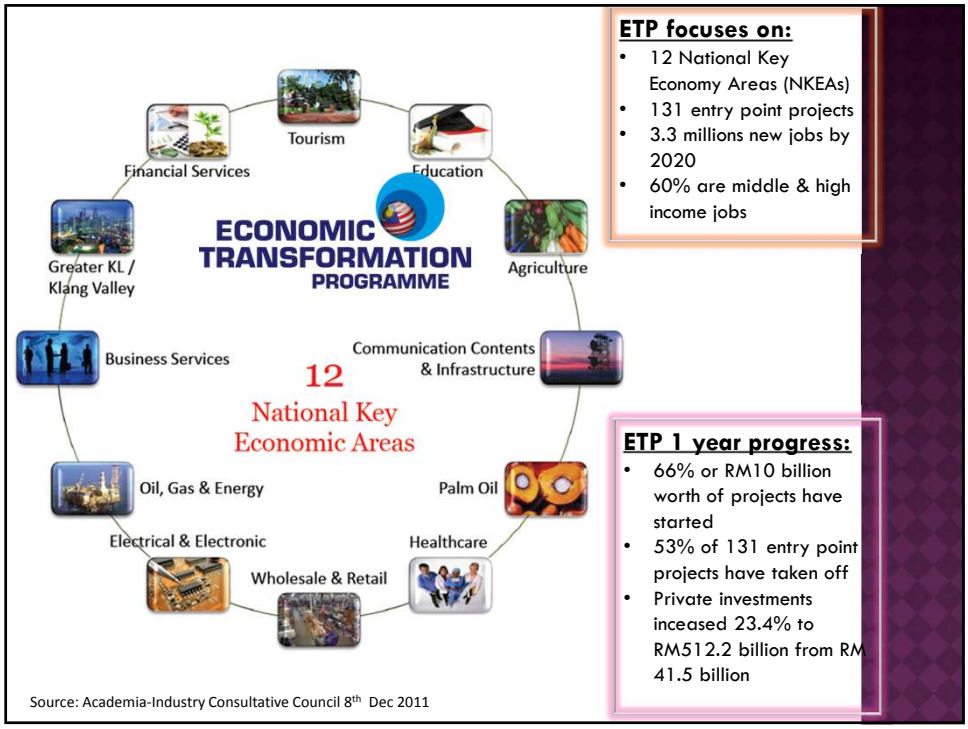
WORLD SCENARIO

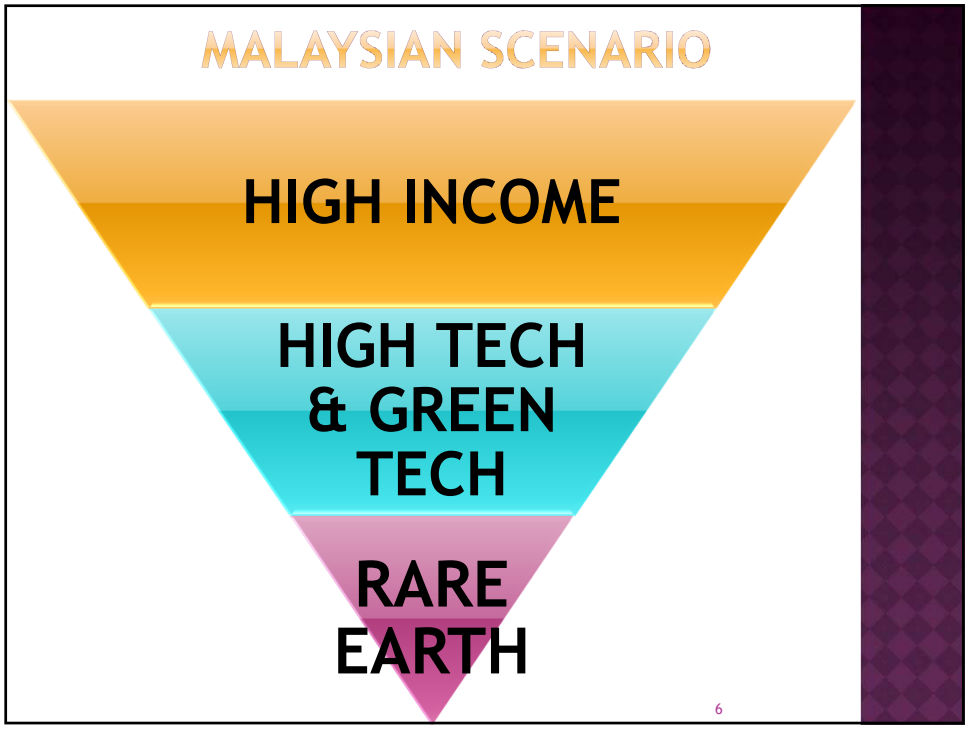





MALAYSIAN SCENARIO
ROADMAP TO VISION 2020
1 Malaysia
People First, Performance Now
Preservation and enhancement of unity in diversity
GTP
GOVERNMENT TRANSFORMATION PROGRAMME
ECONOMIC TRANSFORMATION PROGRAMME
Reducing Crime
Fighting Corruption
Improving Student Outcomes
Raising Standards of Low Income Households
Improving Rural Basic Infrastructure
Improving Urban Public Transport
6 NKRAs
Effective delivery of government services
High Income
Inclusive -ness
Sustainability
New Economic Model
A high income, inclusive and sustainable nation
10th and 11th Malaysia Plan Roll-Out
Implementation of government's development program
Source: Academia-Industry Consultative Council 8th Dec 2011


New Economy Model
HIGH INCOME
Targets US$15,000-20,000 per capita by 2020
CHARACTERISTICS IN 2020
MARKET LED
WELL-GOVERNED
REGIONALLY INTEGRATED
ENTREPRENURIAL
INNOVATIVE
People quality of life
Enables all communities to fully benefit from the wealth of the Country
INCLUSIVENESS
Meets present needs without compromising future generations
SUSTAINABILITY
The Goals


ECONOMIC TRANSFORMATION PROGRAMME
12
National Key Economic Areas
Tourism
Education
Agriculture
Communication Contents & Infrastructure
Palm Oil
Healthcare
Wholesale & Retail
Electrical & Electronic
Oil, Gas & Energy
Business Services
Greater KL / Klang Valley
Financial Services
ETP focuses on:
• 12 National Key Economy Areas (NKEAs)
• 131 entry point projects
• 3.3 millions new jobs by 2020
• 60% are middle & high income jobs
ETP 1 year progress:
• 66% or RM10 billion worth of projects have started
• 53% of 131 entry point projects have taken off
• Private investments inceased 23.4% to RM512.2 billion from RM 41.5 billion
Source: Academia-Industry Consultative Council 8th Dec 2011


MALAYSIAN SCENARIO
HIGH INCOME
HIGH TECH & GREEN TECH
RARE EARTH
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WHY RARE EARTH?

- Green Economy – Climate Change, Alternative and Conservative Energy
- Strategic – "Middle East has Oil, China has Rare Earth" (Deng Xiao Peng 1987)
- Human Capital Development – High Technology Experts

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CHINA'S PROGRAM 863 (IN 1986)

- National High Technology Research and Development Program, namely Program 863
- the objective of the program is to "gain a foothold in the world arena; to strive to achieve breakthroughs in key technical fields that concern the national economic lifeline and national security; and to achieve 'leap-frog' development in key high-tech fields in which China enjoys relative advantages or should take strategic positions in order to provide high-tech support to fulfill strategic objectives in the implementation of the third step of China's modernization process."

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RE IN PROGRAM 863

- mainly meant to narrow the gap in technology between the developed world and China, which still lags behind in technological innovation, although progress is being made.
- focuses on biotechnology, space, information, laser, automation, energy, and new materials.
- The use of rare earth elements can be found in each one of the areas in which Program 863 focuses.

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FATHER OF CHINESE RARE EARTH CHEMISTRY

- **Professor Xu Guangxian**
- **in 2009, at the age of 89, won the 5 million yuan ($730,000) State Supreme Science and Technology Prize, China's = Nobel Prize.**

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ABOUT RARE EARTH .....

ARE NOT REALLY RARE ;

WIDELY SPREAD THROUGH OUT THE EARTH'S CRUST IN SMALL CONCENTRATIONS;

CANNOT BE MINED ECONOMICALLY.

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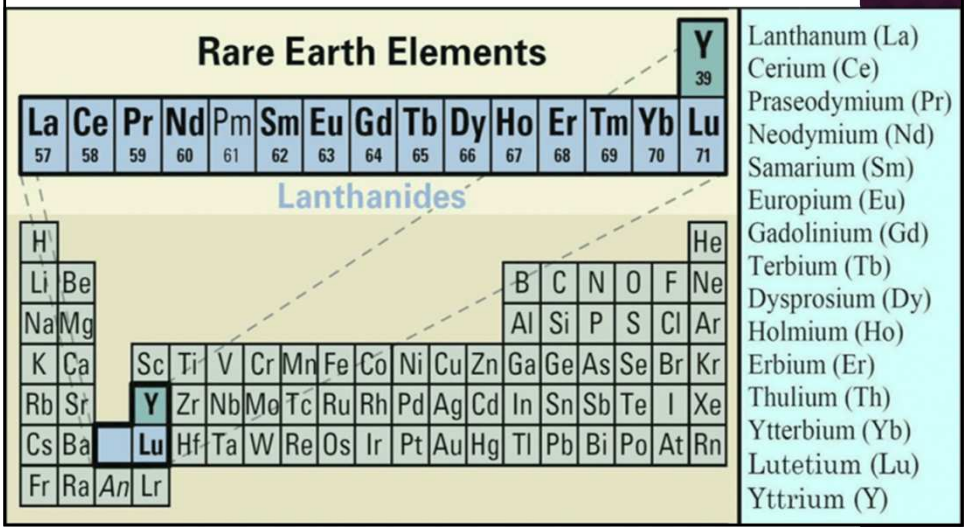
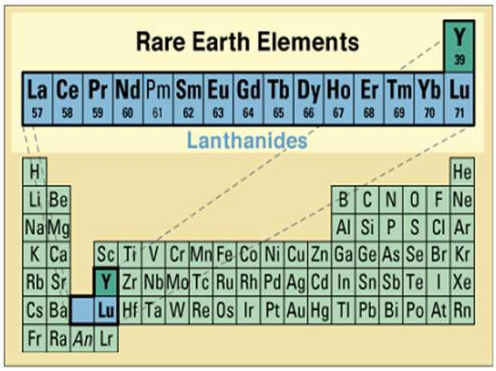
Rare Earth Elements

Rare Earth Elements consist of a group of fifteen elements known as the Lanthanides. The lanthanides are located in block 5d of the periodic table from lanthanum to lutetium



Rare Earths cannot be substituted in many applications

RARE EARTHS: LANTHINIDES PLUS YITTRIUM – UNIQUE PROPERTIES

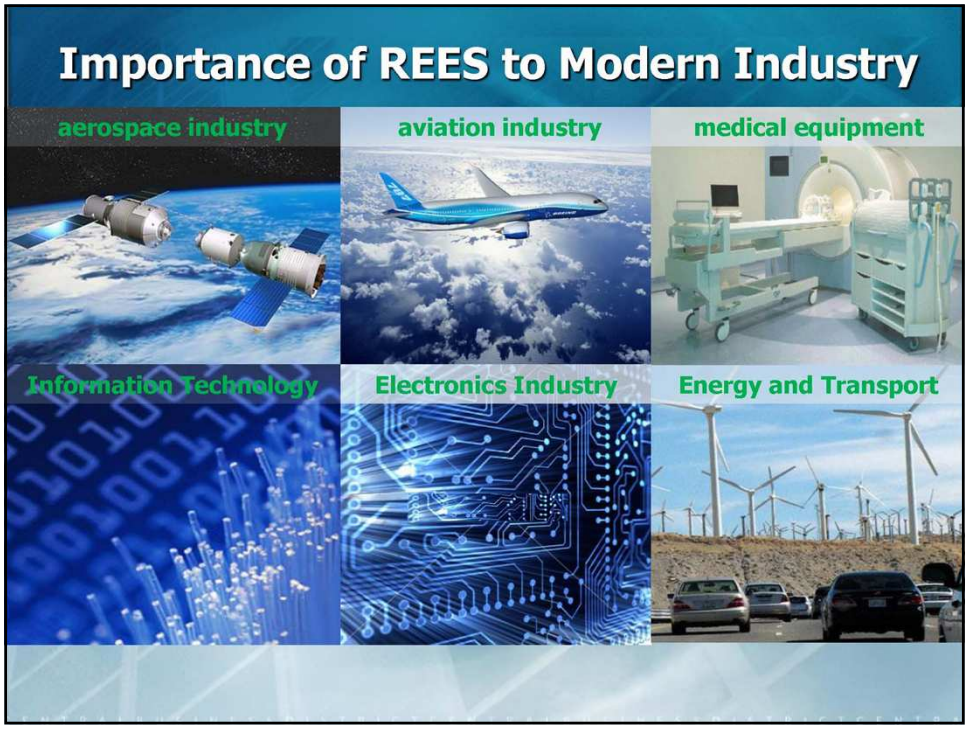


- **Chemical**
  - ➢Unique electron configuration
- **Catalytic**
  - ➢Oxygen storage and release
- **Magnetic**
  - ➢High magnetic anisotropy and large magnetic moment
- **Optical**
  - ➢Fluorescence, high refractive index
- **Electrical**
  - ➢High conductivity
- **Metallurgical**
  - ➢Efficient hydrogen storage in rare earths alloys

Rare Earths underpin new materials technology required to sustain the needs of today's society

Energy efficiency through lower consumption	Environmental protection through lower emissions	Smaller yet more powerful digital technology
		
• Compact Fluorescent Lights • Hybrid vehicle • Weight reduction in cars	• Wind turbine • Auto catalytic converter • Diesel additives	• Flat panel displays • Disk drives • Digital cameras


Rare Earth Advanced Materials
Magnets
catalysts
Phosphor
Hydrogen Storage
Magnetic Cooling
Optical Fiber
Laser Materials
Superconductor Materials
Dielectric Materials
Giant (colossal) magnetoresistance
Magneto-optical storage
Optical Glass&Polishing


Importance of REES to Modern Industry
aerospace industry
aviation industry
medical equipment
Information Technology
Electronics Industry
Energy and Transport


Consumer Electronics


Green Technology
EV
FCEV
Powered By Hydrogen

MARKET DEMAND : SALES OF RE

$ 9.2 BILLION

$ 3 BILLION

2015

2010

Global Demands :
180,000 metric tonnes

Commodityonline, 13th Dec 2011

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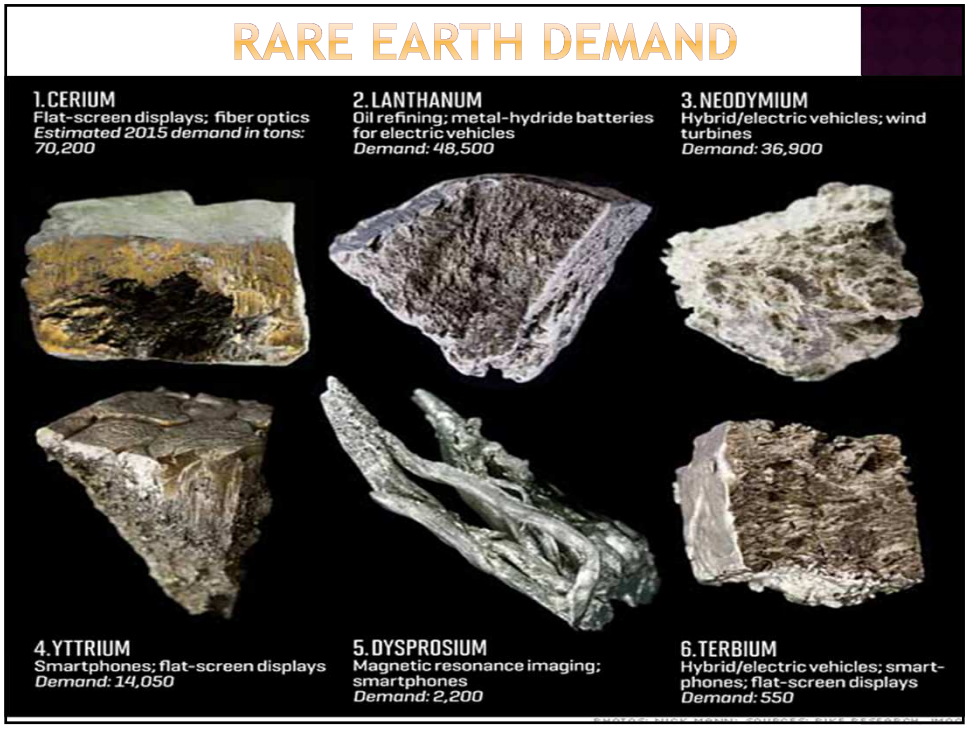
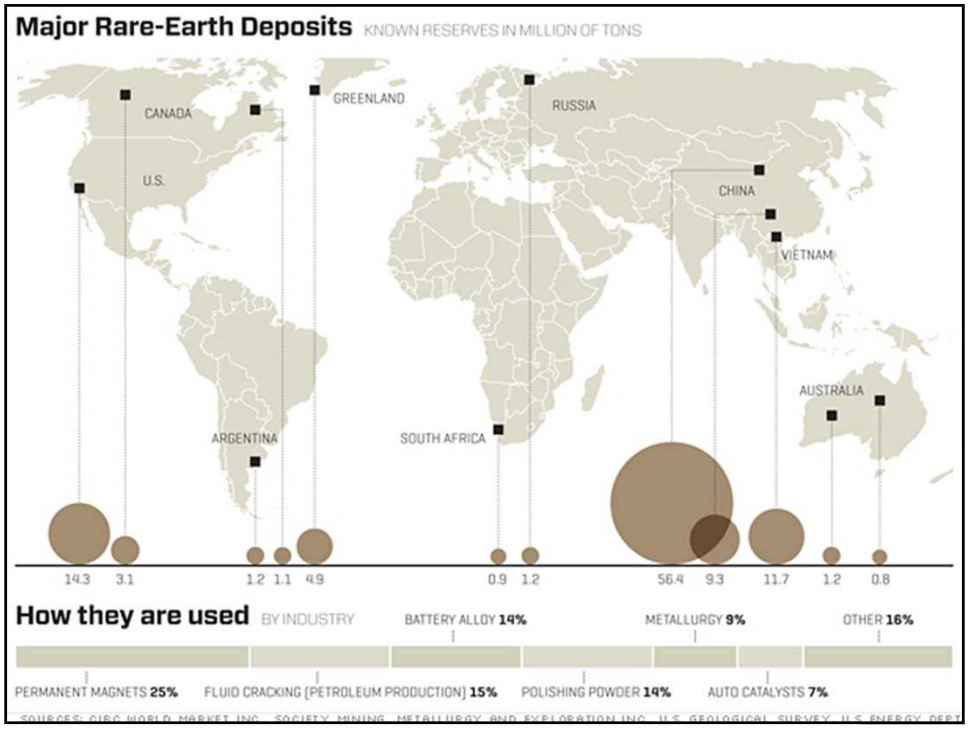


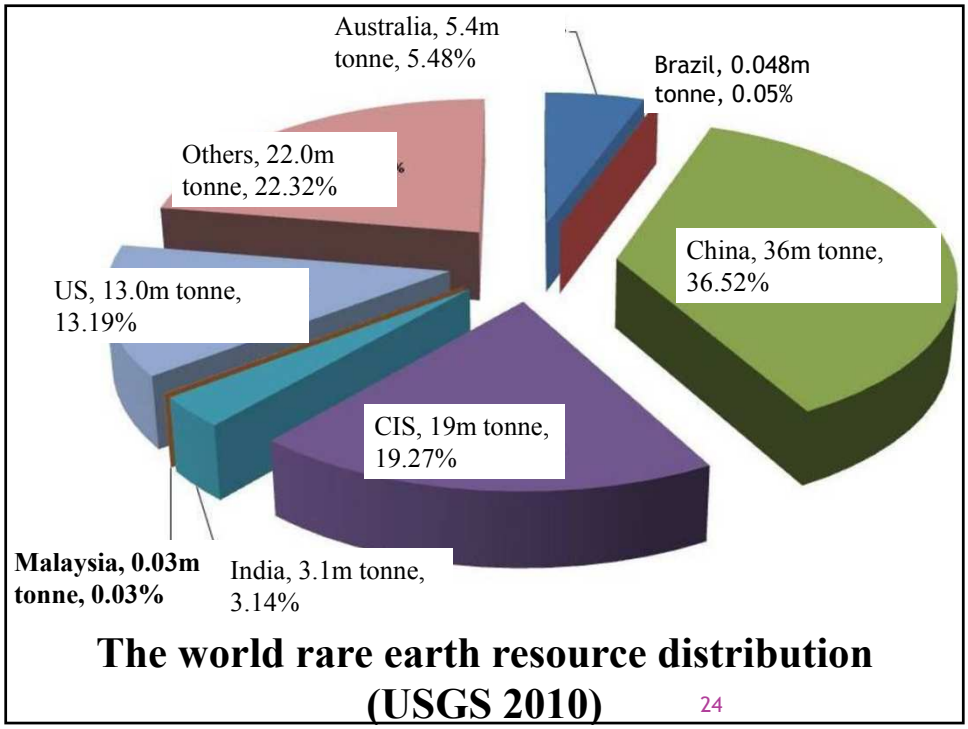
Magnets will be the growth driver for Rare Earths demand to 2014. Polishing powder demand has dropped due to activities to improve productivity

DEMAND FORECAST BY APPLICATION

2010 Demand by Application		
Application	Demand (%)	Demand (t)
• Magnets	25%	31,500
• Battery Alloy	15%	18,600
• Metallurgy ex batt	9%	11,700
• Auto catalysts	7%	9,000
• FCC	17%	21,300
• Polishing Powder	11%	14,000
• Glass Additives	6%	7,800
• Phosphors	6%	7.900
• Others	4%	5,700
Total	**100%**	**127,500**

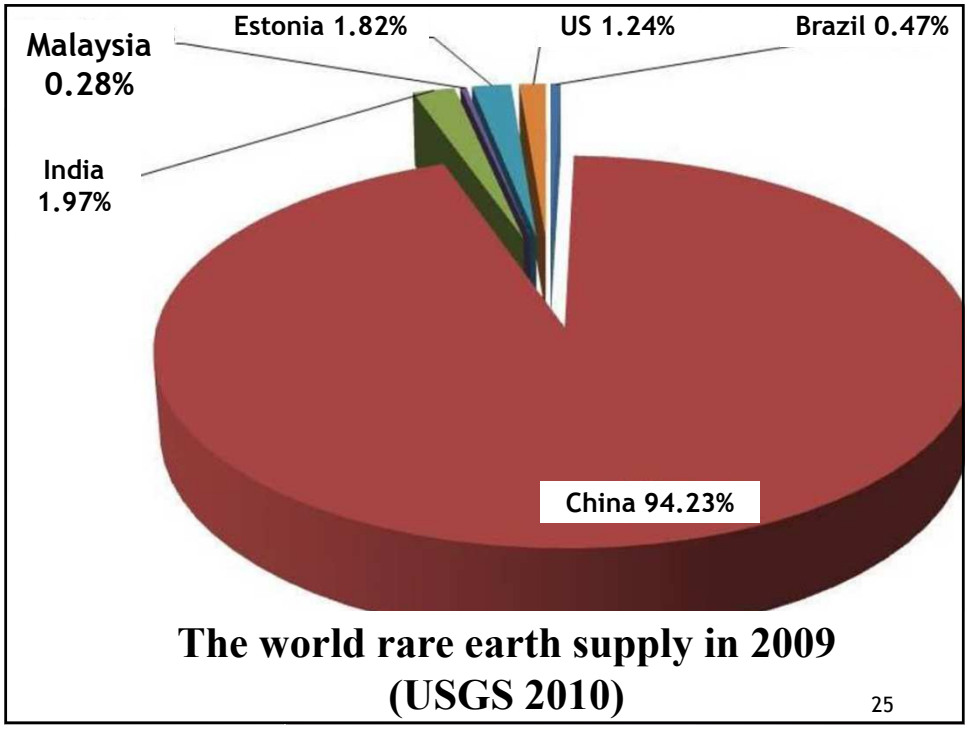
2014 Demand Forecast by Application		
Application	Growth (%)	Demand (t)
• Magnets	12%	49,600
• Battery Alloy	15%	32,500
• Metallurgy ex batt	2%	12,700
• Auto catalysts	8%	12,200
• FCC	4%	24,900
• Polishing Powder	10%	20,600
• Glass Additives	0%	7,800
• Phosphors	8%	10.800
• Others	8%	6,100
Total	**8%**	**177,200**





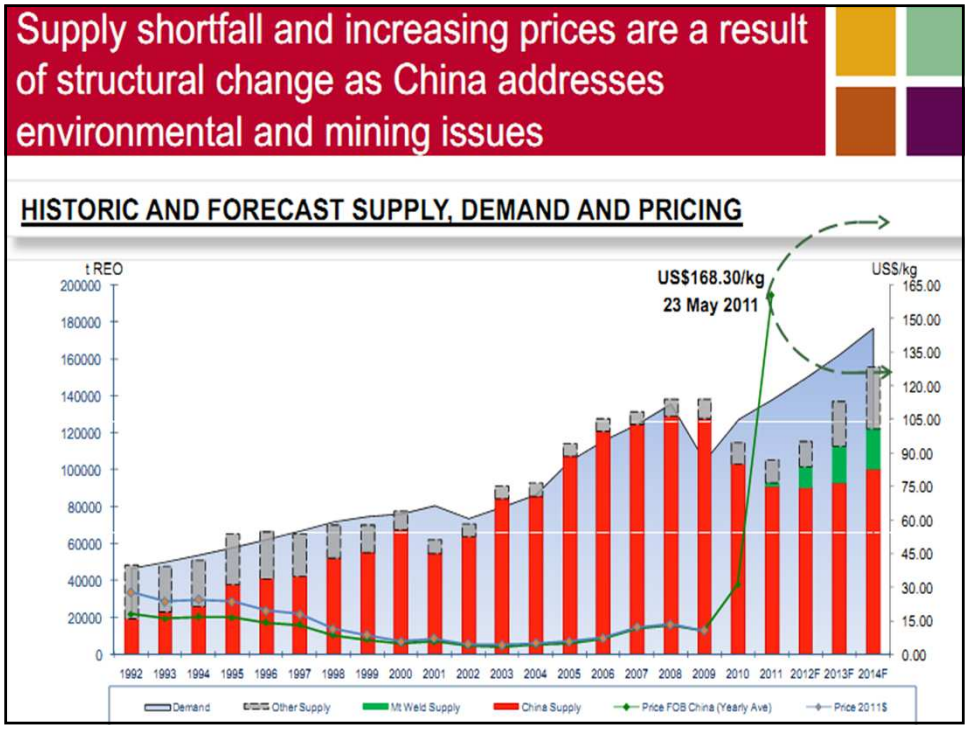
The world rare earth resource distribution (USGS 2010)

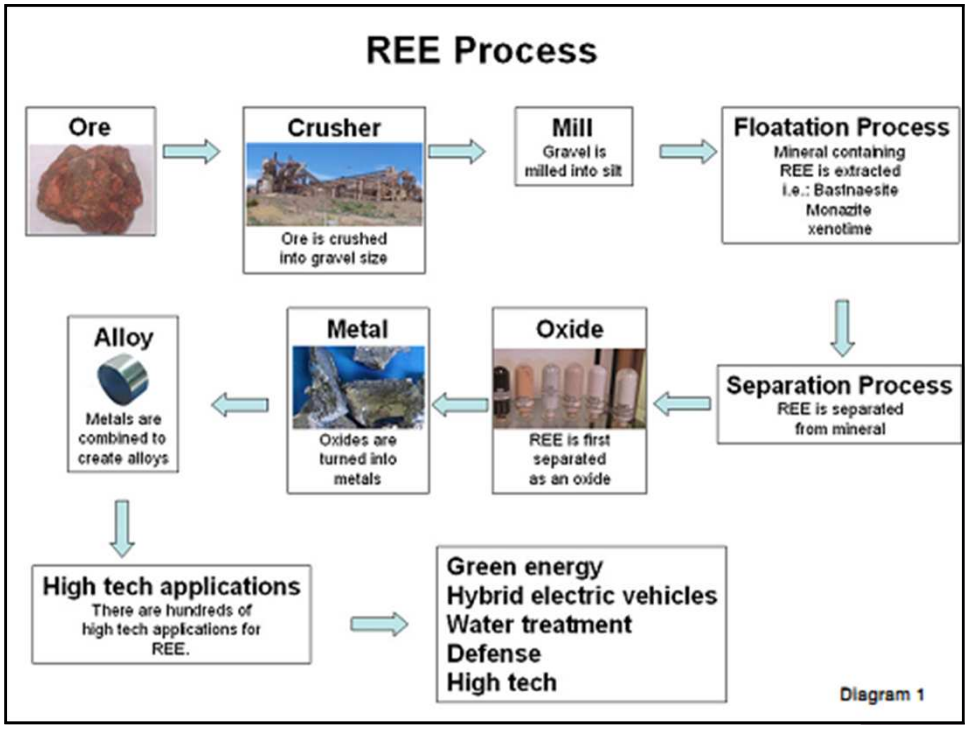
24

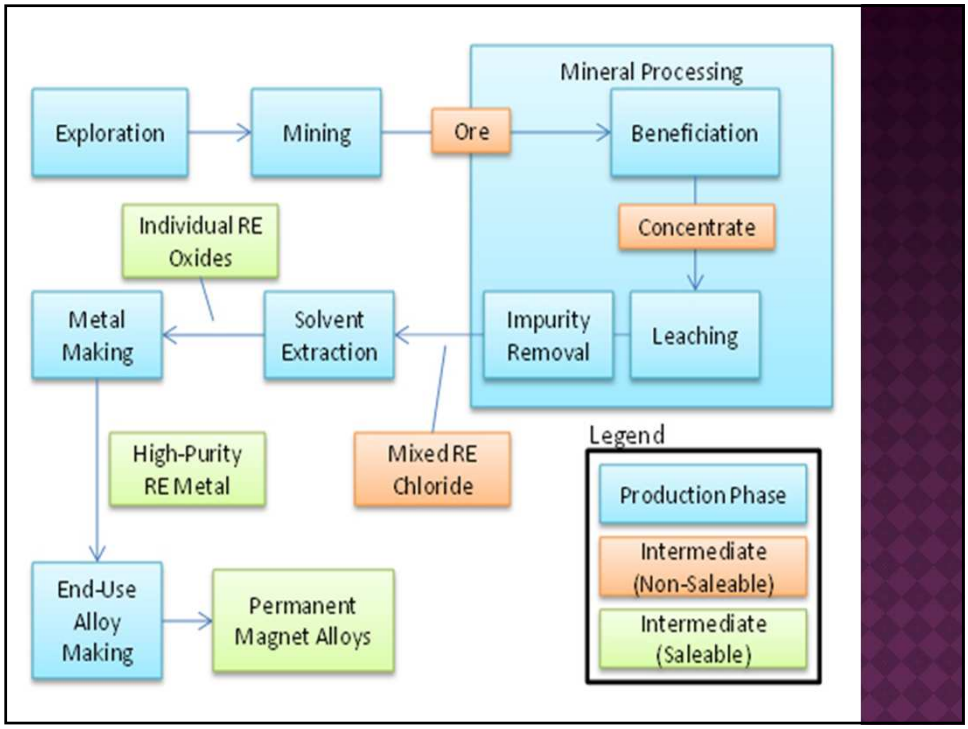


The world rare earth supply in 2009 (USGS 2010)

25




REE Process
Ore
Crusher
Ore is crushed into gravel size
Mill
Gravel is milled into silt
Floatation Process
Mineral containing REE is extracted
i.e.: Bastnaesite
Monazite
xenotime
Separation Process
REE is separated from mineral
Oxide
REE is first separated as an oxide
Metal
Oxides are turned into metals
Alloy
Metals are combined to create alloys
High tech applications
There are hundreds of high tech applications for REE.
Green energy
Hybrid electric vehicles
Water treatment
Defense
High tech
Diagram 1


Mineral Processing
Exploration
Mining
Ore
Beneficiation
Concentrate
Individual RE Oxides
Metal Making
Solvent Extraction
Impurity Removal
Leaching
High-Purity RE Metal
Mixed RE Chloride
End-Use Alloy Making
Permanent Magnet Alloys
Legend
Production Phase
Intermediate (Non-Saleable)
Intermediate (Saleable)

PRODUCTION COST

- USA (Molycorp) - $1.25 / lb
- CHINA - $ 2.53 / lb
- AUSTRALIA (Lynas) - $ 4.59 / lb

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DATA BY TECHNOLOGY METAL RESEARCH [AS OF JUNE 2013]

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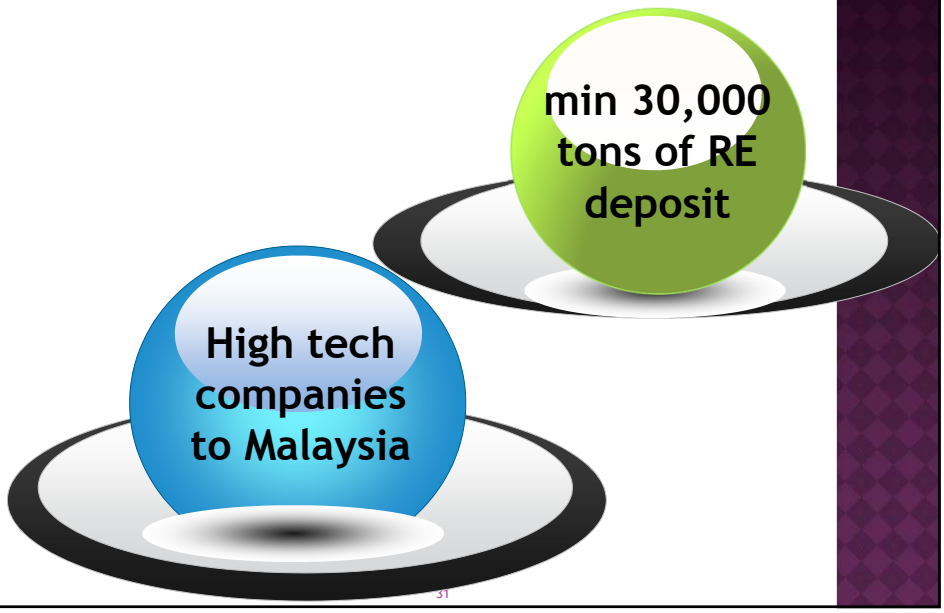
OPPORTUNITY FOR MALAYSIA



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PERSPECTIVES FROM

AKADEMI SAINS MALAYSIA(ASM) & MAJLIS PROFESOR NEGARA (MPN)

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RECOMMENDED STRATEGIES

- Enhance the environment, safety and health aspects of the management of industrial estates
- Undertake a national exercise to map the potential rare earths alluvial and hard-rock deposits
- Incentivise the upstream mining and extraction of rare earths through partnership with global enterprises

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RECOMMENDED STRATEGIES

- Incentivise investments in the downstream manufacturing of rare-earth based products
- Build the key competence in human capital for the entire value chain of the rare earths business

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RECOMMENDED STRATEGIES

Strengthen the legal and regulatory framework to enable the effective functioning of the rare earths business

Undertake coordinated, comprehensive and continual public awareness program & community engagement

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R&D OPPORTUNITY

- Automotive industry
  - Hybrid and EV Vehicles
  - Catalytic Converter
  - NIH Battery
  - Fuel additives
- Superconducting magnets
- Rare Earth Recycling
- Rare Earth Processing
- Utilisation of gypsum byproducts

Local universities to lead!

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MALAYSIAN RARE EARTH R&D GROUP

UNIVERSITIES

- UMP & UTAR (Lead), UTEM, UTP, UKM

RESEARCH AREA

- Mining Engineering, Material Science and Engineering, Processing, Environmental & Safety, Nuclear Fuel Technology, Automotive.

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RARE EARTH R&D AT UMP

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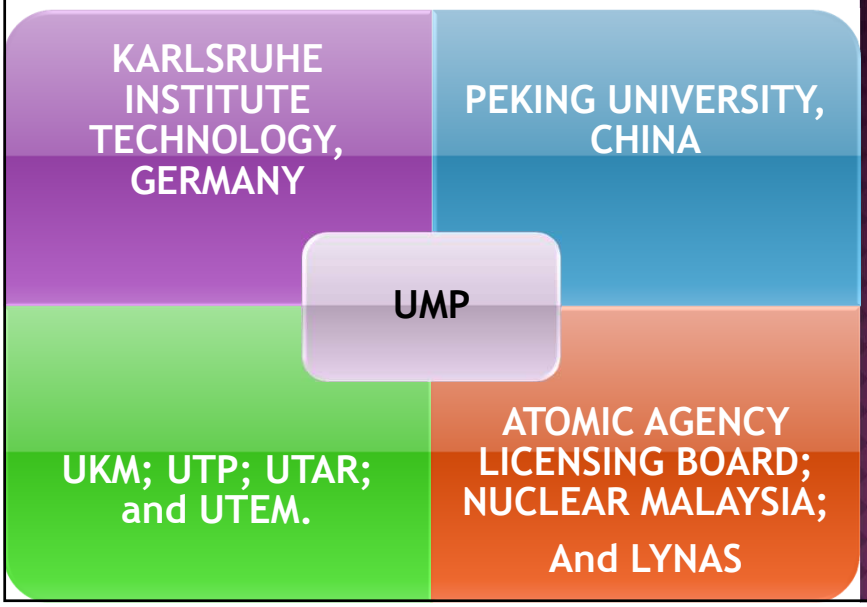
NATIONAL & INTERNATIONAL COLLABORATION



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THANK YOU

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