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

BADHRULHISHAM BIN ABDUL AZIZ
UNIVERSITI MALAYSIA PAHANG
28TH AUGUST 2013

WORLD SCENARIO

CLIMATE CHANGE

FOOD & WATER

SHORTAGE OF RESOURCES
**MALAYSIAN SCENARIO**

**ROADMAP TO VISION 2020**

**The Goals**

- **HIGH INCOME**
  - Targets US$15,000-20,000 per capita by 2020

- **SUSTAINABILITY**
  - Meets present needs without compromising future generations

- **INCLUSIVENESS**
  - Enables all communities to fully benefit from the wealth of the Country

**CHARACTERISTICS IN 2020**

- MARKET LED
- WELL-GOVERNED
- REGIONALLY INTEGRATED
- ENTREPRENEURIAL
- INNOVATIVE

**Source:** Academia-Industry Consultative Council 8th Dec 2011
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 increased 23.4% to RM512.2 billion from RM41.5 billion

Malaysian Scenario

HIGH INCOME

HIGH TECH & GREEN TECH

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

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.”
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.

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.
ARE NOT REALLY RARE;

WIDELY SPREAD THROUGHOUT THE EARTH’S CRUST IN SMALL CONCENTRATIONS;

CANNOT BE MINED ECONOMICALLY.

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.

<table>
<thead>
<tr>
<th>Rare Earth Elements</th>
<th>Periodic Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lanthanum (La)</td>
<td>57</td>
</tr>
<tr>
<td>Cerium (Ce)</td>
<td>58</td>
</tr>
<tr>
<td>Praseodymium (Pr)</td>
<td>59</td>
</tr>
<tr>
<td>Neodymium (Nd)</td>
<td>60</td>
</tr>
<tr>
<td>Samarium (Sm)</td>
<td>62</td>
</tr>
<tr>
<td>Europium (Eu)</td>
<td>63</td>
</tr>
<tr>
<td>Gadolinium (Gd)</td>
<td>64</td>
</tr>
<tr>
<td>Terbium (Tb)</td>
<td>65</td>
</tr>
<tr>
<td>Dysprosium (Dy)</td>
<td>66</td>
</tr>
<tr>
<td>Holmium (Ho)</td>
<td>67</td>
</tr>
<tr>
<td>Erbium (Er)</td>
<td>68</td>
</tr>
<tr>
<td>Thulium (Tm)</td>
<td>69</td>
</tr>
<tr>
<td>Ytterbium (Yb)</td>
<td>70</td>
</tr>
<tr>
<td>Lutetium (Lu)</td>
<td>71</td>
</tr>
<tr>
<td>Yttrium (Y)</td>
<td>39</td>
</tr>
</tbody>
</table>
Rare Earths cannot be substituted in many applications

**RARE EARTHS: LANTHANIDES PLUS YTTRIUM – 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

<table>
<thead>
<tr>
<th>Energy efficiency through lower consumption</th>
<th>Environmental protection through lower emissions</th>
<th>Smaller yet more powerful digital technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compact Fluorescent Lights</td>
<td>Wind turbine</td>
<td>Flat panel displays</td>
</tr>
<tr>
<td>Hybrid vehicle</td>
<td>Auto catalytic converter</td>
<td>Disk drives</td>
</tr>
<tr>
<td>Weight reduction in cars</td>
<td>Diesel additives</td>
<td>Digital cameras</td>
</tr>
</tbody>
</table>

22/10/2015
Rare Earth Advanced Materials

- Magnets
- Catalysts
- Phosphor
- Hydrogen Storage
- Magnetic Cooling
- Optical Fiber
- Laser Materials
- Supercapacitor 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
Global Demands:
180,000 metric tonnes

Commodityonline, 13th Dec 2011
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**

<table>
<thead>
<tr>
<th>Application</th>
<th>Demand (%)</th>
<th>Demand (t)</th>
<th>2014 Demand Forecast by Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnets</td>
<td>25%</td>
<td>31,500</td>
<td>Magnets</td>
</tr>
<tr>
<td>Battery Alloy</td>
<td>15%</td>
<td>18,600</td>
<td>Battery Alloy</td>
</tr>
<tr>
<td>Metallurgy ex batt</td>
<td>9%</td>
<td>11,700</td>
<td>Metallurgy ex batt</td>
</tr>
<tr>
<td>Auto catalysts</td>
<td>7%</td>
<td>9,000</td>
<td>Auto catalysts</td>
</tr>
<tr>
<td>FCC</td>
<td>17%</td>
<td>21,300</td>
<td>FCC</td>
</tr>
<tr>
<td>Polishing Powder</td>
<td>11%</td>
<td>14,000</td>
<td>Polishing Powder</td>
</tr>
<tr>
<td>Glass Additives</td>
<td>6%</td>
<td>7,800</td>
<td>Glass Additives</td>
</tr>
<tr>
<td>Phosphors</td>
<td>6%</td>
<td>7,900</td>
<td>Phosphors</td>
</tr>
<tr>
<td>Others</td>
<td>4%</td>
<td>5,700</td>
<td>Others</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
<td><strong>127,500</strong></td>
<td></td>
</tr>
</tbody>
</table>
The world rare earth resource distribution (USGS 2010)
The world rare earth supply in 2009 (USGS 2010)

Supply shortfall and increasing prices are a result of structural change as China addresses environmental and mining issues.
PRODUCTION COST

USA (Molycorp) - $1.25 / lb

CHINA - $2.53 / lb

AUSTRALIA (Lynas) - $4.59 / lb

DATA BY TECHNOLOGY METAL RESEARCH [AS OF JUNE 2013]

- 47 advanced rare earth projects
- 52 rare-earth mineral resources
- 15 different countries
- 44 different companies
OPPORTUNITY FOR MALAYSIA

High tech companies to Malaysia

min 30,000 tons of RE deposit

PERSPECTIVES FROM

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

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
**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

**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**
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.
NATIONAL & INTERNATIONAL COLLABORATION

KARLSRUHE INSTITUTE TECHNOLOGY, GERMANY

PEKING UNIVERSITY, CHINA

UMP

UKM; UTP; UTAR; and UTEM.

ATOMIC AGENCY LICENSING BOARD; NUCLEAR MALAYSIA; And LYNAS

REFERENCES

1. Report Parliament Select Committee on Lynas Advanced Materials Plant (LAMP); Dewan Rakyat, Ke 12, Penggal ke 5, 2012.
5. LYNAS Investor Presentation; May 2011.
6. www.techmetalsreseach.com; 2013