

Understanding China's Rare Earth Monopoly



Rare Earths are a cornerstone of China's military & economic strategy to achieve global hegemony

Why all U.S. efforts have failed to overcome this threat?

What is the solution?

Congressional Briefing: July 26, 2019 – Capitol Building Senate Visitor Center Room 215

Speakers: General John Adams (Ret.), Ned Mamula, James Kennedy, Marc Noga, John Kutsch & J.J. Brown

Outline Of Presentation:

Understanding China's State Sponsored Monopoly

- How It Operates

- What Are Its Goals

- Warnings Ignored

Understanding Its Commercial Dimensions

- Scope of State Sponsored Research

- Relative Achievements in IP & R&D

Understanding Its Military Dimensions

- Leadership In RE Dependent Weapon Systems

- Militarized Mercantilism

Understanding its Offensive & Defensive Structure

- Why Opening New Rare Earth Mines Cannot Save Us

Why Its All About Metal

- Introduction: Marc Noga & Facts On The Ground

Why Thorium Byproduct Utilization Is Critical

- Lessons In Chemistry

- Utilizing Abundant Uninterruptable Resources

How The Rare Earth Cooperative Will Work

Rare Earths Are One Of The Defining Economic & National Security Issues Of Our Day

The GAO has determined that:

'rare earths are a bedrock national security issue'

&

'China can use rare earths to halt the procurement of multiple RE-dependent U.S. weapons systems'

With such definitive National Security concerns and 10 years of Congressional scrutiny* you would think this problem would have been solved, but the situation has only gotten worse

* Congress has offered at least two dozen bills that deal with rare earths since 2008

Why ? Because this is not a market-based problem

All traditional 'free market' challenges to China's monopoly have and will continue to fail in overcoming China's monopoly

The reasons for this are built into China's state sponsored monopoly

The following slides highlight many of these reasons, but not all of them

China's rare earth programs were initiated at the highest levels of government:

- Deng Xiaoping and Jiang Zemin initiated Programs 863 and 973 respectively (making rare earths a top priority for China)
- Xi Jinping and Wen Jiabao maintained foreign investment, export, tariff and trade restrictions on rare earths while continuing internal subsidies and investment into the industry
- Deng Xiaoping's family acquired & relocated the world's most advanced rare earth magnet company, a \$70 million asset at the time (circa mid-1990s)
 - This U.S. company, Magnequench, was the only domestic producer of rare earth magnets for all U.S. guided weapon systems
- Xi Jinping's family held nearly \$400 million in rare earth processing assets as early as 2012

*Imagine if a series of U.S. Presidents held significant financial interest in a strategic commodity or industry... Could / would that influence the economic or military policies of the United States ... (?) | **DARK HUMOR***

For China, rare earths are a loss leader as part of its hyper-mercantile strategy of economic and military domination

Access to these materials is used as leverage to force RE dependent technologies to migrate to China and create dependency issues for U.S. defense contractors

This strategy has been so successful that entire U.S. & multi-national industries have moved operations to China and defense contractors have expressed concerns over supply disruption

The commercial consequence has been the global aggregation of intellectual property, manufacturing and profits inside China

While denying these profits and corresponding tax revenues to its adversaries

The militaristic consequence has resulted in China's ability to cut off its adversaries' access to these materials. Note: The U.S. and NATO are 100 percent dependent on China for all metallic forms of rare earths

While cultivating dependency relationships with western defense contractors

All of China's actions are consistent
with the findings of the 1999
Congressional Report on

“U.S. NATIONAL SECURITY AND
MILITARY/COMMERCIAL CONCERNS WITH
THE PEOPLE'S REPUBLIC OF CHINA”

SUBMITTED JANUARY 3, 1999 BY MR. COX OF CALIFORNIA,
CHAIRMAN OF THE SELECT COMMITTEE

From the 1999 Cox Report:

“In 1997, the CCP formally codified the 16-Character Policy. The “16-Character Policy” is the CCP’s overall direction that underlies the blurring of the lines between State and commercial entities, and military and commercial interests. The sixteen characters literally mean:

- Jun-min jiehe (Combine the military and civil)
- Ping-zhan jiehe (Combine peace and war)
- Jun-pin youxian (Give priority to military products)
- Yi min yan jun (Let the civil support the military)”

In 1997, the PRC formally codified Deng Xiaoping's "16-Character Policy," which literally means: Combine the military and civil, combine peace and war; give priority to military products; let the civil support the military.

“This policy, a reaffirmation and codification of Deng Xiaoping’s 1978 pronouncement, holds that military development is the object of general economic modernization, and that the CCP’s main aim for the civilian economy is to support the building of modern military weapons and to support the aims of the PLA.”

This is also observable in China's demonstrated success in eclipsing all other nations in the areas of rare earth related basic science, IP, R&D and military & commercial development of next-generation technologies

These state sponsored program are arguably more ambitious and far sighted than the U.S. Manhattan Project during WW2

China has two large cities exclusively focused on rare earths. The cities are officially referred to as “rare earth cities”



A significant portion of Baotou and Ganzhou's 17 million inhabitants are directly or indirectly supporting China's Rare Earth program

The cities combined population is about 15 times larger than the U.S. Manhattan Project during its peak of activity

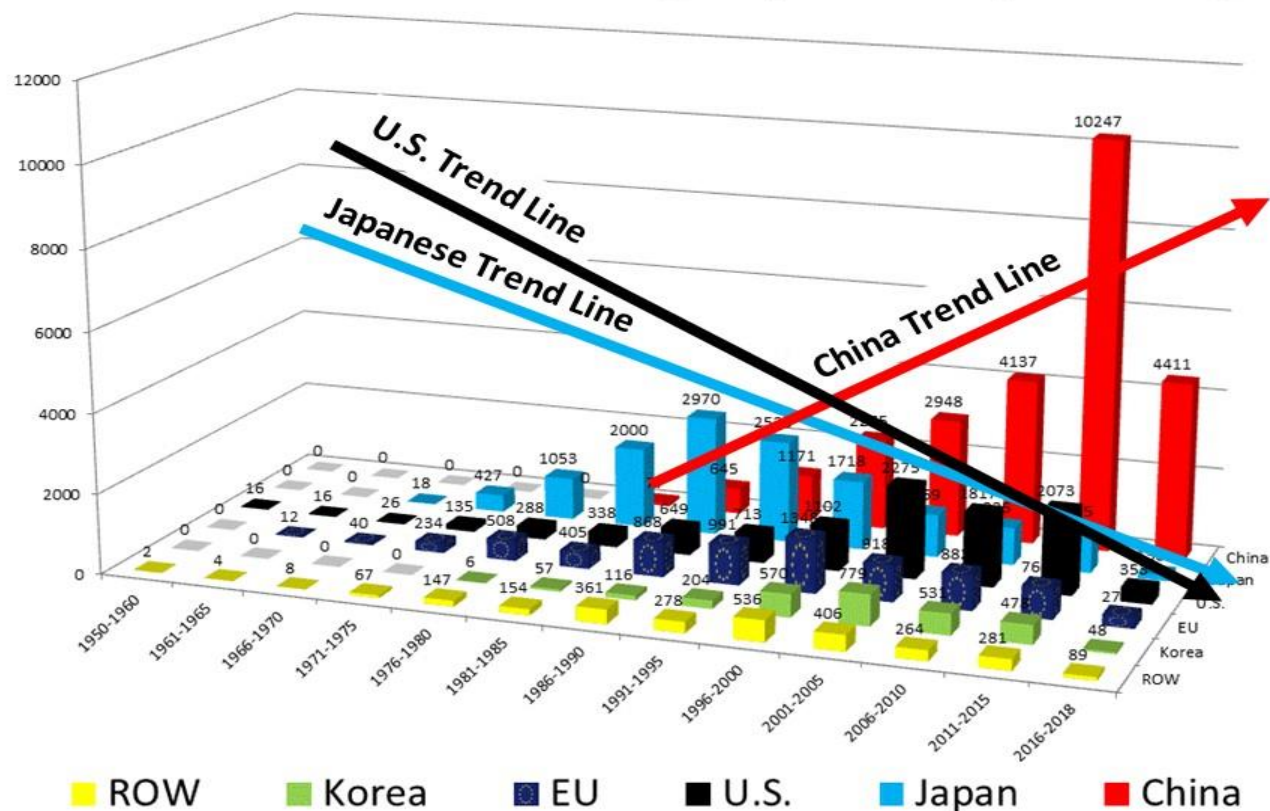
To put things into perspective, the Chinese Government has established 5 national labs that exclusively focus on rare earths

- 1985 China establishes the Baotou Research Institute of Rare Earths in recognition of the PRC's focus on Rare Earths. Beginning in 1985, **this facility became and remains the largest dedicated rare earth research facility in the world**
- 1987 China establishes the Changchun Institute of Applied Chemistry – focused on the chemistry and physics of rare earths
- 1991 China establishes Key Laboratory – focused on chemistry and applications of rare earths and the Chinese State Planning Commission formally places the entire rare earth industry under state control
- 1999 China establishes the Xiyuan Inner Mongolia Functional Materials Engineering and Technology Research Center – focused on Functional Materials Engineering
- 2001 China establishes the National Engineering Research Center of rare earth metallurgy and materials - focused primarily on Metallurgy

The U.S. only has one National Lab working on rare earths, but that work has been insignificant relative to its overall budget during this timeframe

China has eclipsed the rest of the world in rare earth basic science, IP and R&D research

International Patent Filings By Country Of Origin



China files more rare earth patents each year than the rest of the world combined

By sometime in 2021 China will have filed more RE patents than the rest of the world combined

This state sponsored patent strategy is effectively 'ring-fencing' all existing non-Chinese patents and will be used to block or challenge non-Chinese patent filings in the future

Sometime in the not-too-distant future China will become the international champion and enforcer of IP

China is leading the U.S. in almost all areas of Next-Generation weapon systems. Many of these Chinese systems have been tested or deployed

- **Quantum computing, satellite & encryption technology** ([here](#), [here](#), [here](#), [here](#)), ([here](#)).
- **Kinetic Energy weapons** ([here](#), [here](#), [here](#)), ([here](#))
- **Hypersonic weapons** ([here](#), [here](#), [here](#))
- **Directed Energy weapons & control over U.S. access to materials*** ([here](#)), ([here](#))
- **Space Force weapon tests and deployment** ([here](#)), ([here](#))
- **Nuclear powered weapon systems** ([here](#), [here](#), [here](#))

All of these systems require ultra-high purity rare earth materials in post-oxide forms. The U.S. has no domestic capabilities to produce these materials*

Beyond this, other *Ultra-National Military & Mercantile-Economic Strategies* have been initiated

In 2017 a new Chinese National Intelligence Law now requires

“all Chinese organizations and citizens to support, cooperate, and collaborate in [Chinese] national intelligence work”.

This law makes every Chinese citizen a duty-bound spy for China, including those working in our National Labs, for defense contractors and at our universities.

- *China has also made it known to recent expats that they consider anyone of ‘Chinese decent’ a citizen*

Offensive & Defensive Structures Of China's Monopoly

China's monopoly is designed to eliminate (or moderate in the case of resource production) competitive threats at every level of the resource, oxide and post-oxide value chain

Historically China's official stated rare earth resource, oxide and post-oxide production "capacity" has been maintained at two times official production levels

The Chinese government estimates that ongoing 'black market' production is at least 150% of its official production numbers

That puts China's total internal capacity at 350% of its current level of production – or close to 3 times global demand

China produces 80% of the world's RE resources and processes close to 90% of the world's oxides

China also produces over 95% of the world's base rare earth metals

- The balance is almost entirely Japan, or Japanese controlled, and Japan relies on China for close to 90% of its internal RE metal needs

This means that there are no non-Chinese metals, alloys or magnets, ex-Japan, that did not originate from China (including recycled metals)

Btw: China consumes ~ 75% of what it produces

Most of China's Monopoly Leverage Is At The Post-Oxide & Metallurgical Level

- In fact, China has made it clear that they intend to rely on other nations to become their resource supplier in the future
- Representatives of China have publicly stated that resource producers will be free to ship RE resources to China but will not be allowed to advance up the value chain (beyond oxides)

China's control over non-Chinese technology and defense companies is at the post-oxide level – they will not give this up

To speak about how this plays out in the defense, aerospace and auto industry is Marc Noga

Marc has been involved with the application of rare earth materials in motors for over 25 years

His work includes designing and sourcing rare earth materials into automotive, medical, aerospace and defense applications, including existing, experimental and prototype weapon systems

His talk will focus on China's control over U.S. access to metals and magnets that go into these systems

Motor Industry Basics

- Permanent Magnet DC Motors accounted for about \$22.5 Billion in worldwide sales in 2018
- Asia Pacific, Europe and North America are the biggest regions
- Worldwide projected CAGR for this technology is 6.1% through 2025

Rare Earth Materials in Motor Industry

- Magnets are where we find RE materials
- Old technology of ferrite magnets, still widely used but energy products peak at around 4.3 MGOe
- RE magnets: SmCo has 8X energy product, NdFeB has more than 10X energy product
- This enables smaller, lighter and more power dense motors – critical in Aerospace and Defense

Applications

- There are too many to list – virtually all new A&D motor applications use RE magnets
- As we speak I am actively working on ER-GMLRS, AARGM, Hellfire, Taurus Missile and JSF
- All use SmCo or NdFeB – as well as other Rare Earth additives (e.g. Dysprosium)

Challenges

- Previous “work-arounds” for ITAR projects allowed use of Chinese RE if final grind/coat/magnetize was in the USA
- This option is eliminated with HR 5515, barring Secretary of Defense waiver
- Domestic magnet supply base scrambling to figure out how to replace Chinese mined materials
- Even if mined elsewhere, China will still have to participate in value chain before material arrives in US

Practical Impact

- RE Magnets are the long lead item in assemblies already, now it will be longer
- This extends product development life cycles at the very bottom of the value chain
- I am currently seeing 7X to 15X price increases for RE magnets to comply with HR 5515
- This is especially painful as RE magnets were *already* the highest cost component in most machines
- Bottom line: Cost Up – Development and Prototype Cycles Extended

Questions?

Continued: China's Offensive & Defensive Advantages And Strategies

Over 50% of China's current rare earth production is the byproduct of an iron ore mine, with no direct mining cost

- **How do any U.S. producers compete with that?**

China is not subject to the 1980 NRC / IAEA regulation* that defined thorium bearing rare earth byproducts as "Source Material" and is free to utilize these resources

- *This amendment to 10 CFR 40 was the primary driver for China's successful entrance into the rare earth industry, including the transfer of western processing and metallurgical technology to China

These materials are also a no-cost byproduct to China

The 1980 NRC / IAEA regulation has forced non-Chinese mining operations to develop deposits with low levels of thorium

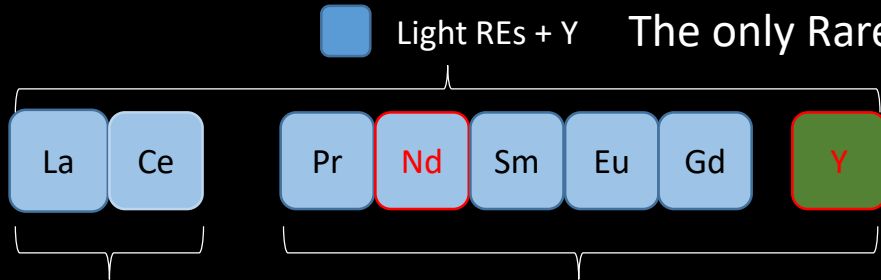
These deposits typically do not contain recoverable levels of the heavy lanthanides

- Resulting in significant economic vulnerability
- To make matters worse, typically about 80% of their rare earth production can result in operating losses (due to its light RE distribution)

Consequently, their rare earth distribution is incompatible with U.S. technology and defense needs

Bastnasite & other low thorium-bearing ores are not compatible with U.S. tech & defense industry needs

What does MP Mine actually produce ?

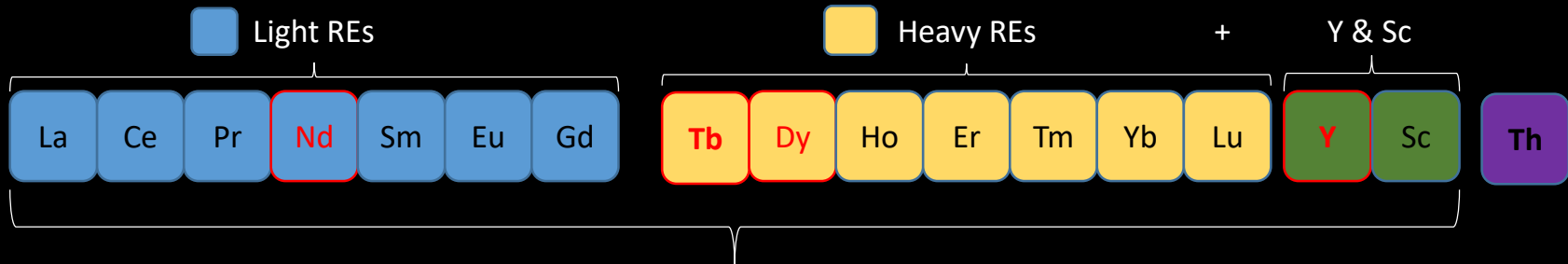


From a typical Bastnasite deposit.

MP Mine cannot produce any of the heavy lanthanides and has never produced a commercial quantity of Yttrium

*Sells below production cost – generates losses Shipped to China

FULL Rare Earth distribution: common in Monazite and other Thorium bearing deposits



Monazite and Apatite typically contain recoverable levels for all of the rare earths

*La and Ce make up over 83% of the rare earth distribution within the Mt. Pass deposit

China has lower labor, capital and environmental compliance costs and can sustain operating losses as long as the central government permits

In short, China is the market, sets price and can drive any competitor out of business at the mining, oxide or metallurgical level

- For example, most non-Chinese rare earth mines economic viability is based on just two rare earth elements (Praseodymium & Neodymium)

If China lowers the price of these two materials enough all of these non-Chinese mining companies would go bankrupt

Rare earth concentrates and oxides have no significant technology or defense application

The U.S. does not have post-oxide capabilities

China is the only country in the world with the capacity and a fully integrated value chain capable of converting these materials into metals, alloys, magnets and other post-oxides materials

This forces U.S. and other RE producers to ship their concentrates and oxides to China

It should be obvious that opening new RE mines to supply China is not the answer...

The hard reality is that no non-Chinese rare earth mine has any protection from Chinese monopoly pricing power and, thus, cannot be relied on

Consequently, developing post-oxide & metallurgical capabilities without first securing an uninterruptable supply of adequate resources is economic folly and inconsistent with our National Security needs

A solution is needed.

Absent subsidies, the resource security issue can only be resolved by allowing the utilization of Th-REE resources (the primary pre-1980 historical resource)

The U.S. produces enough recoverable Th-REEs to supply the entire non-Chinese world



Th-REE Bearing Monazites, Apatite & other RE

Phosphates are typically dumped as tailings by:

- Phosphate Mines
- Heavy Mineral Sand – Titanium / Zircon Placer Mines
- Iron Ore Mines, Uranium, Aluminum, Copper, Cobalt, Mines, etc.
- Bastnasite Rare Earth Mines

By utilizing Th-REEs from existing mines the rare earth supply chain becomes uninterrupted

Rare Earth Distribution % | By Mineralization

	Chinese Byan Obo	HRE-China Ionic Laterite		Mt. Pass Bastnasite	Selected Monazite	Selected RE-Apatite	Florida Phosphate*	
Lanthanum	27.1	1.8	Light Lanthanides 	33.8	21	18.6	25	9.8
Cerium	49.8	0.4		49.6	45	34.6	20	24.7
Praseodymium	5.15	0.7		4.1	5.0	3.5	5.1	3.7
Neodymium	15.4	3.0		11.2	19	12.7	12.1	16.7
Samarium	1.15	2.8		0.9	3.0	2.5	5.1	4.2
Europium	.19	0.1		0.1	0.2	0.3	0.7	.9
Gadolinium	0.4	6.9		0.2	2.6	2.8	2.4	5
Terbium	0.0	1.3	Heavy Lanthanides 	0.0	0.3	0.5	0.7	.6
Dysprosium	0.3	6.7		0.0	1.1	2.8	2.8	3.5
Holmium	0.0	1.6		0.0	.13	0.5	0.7	.6
Erbium	0.0	4.9		0.0	.27	1.8	3.6	1.4
Thulium	0.0	0.7		0.0	0.2	0.2	0.3	.1
Ytterbium	0.0	2.5		0.0	0.1	1.5	1.4	.1
Lutetium	0.0	0.4		Trace	0.2	0.2	0.5	.7
Yttrium	0.2	65.0		0.1	3.3	17.5	19	24.7
Scandium	0.0	Trace		0.0	Trace	Trace	0.5	.6
Percent Heavy	0.3%	18.1%		0.0%	4.7%	7.5%	11 – 35%**	
Heavy + Y	0.5%	83.1%		0.1%	8%	25%	30 – 60%**	
RE in Ore	5%	0.2%		8%	+50%	3%	3100 – 16600 ppm	
Percent Th / U	0.3%	>.1%		0.1%	3 - 8%	1%	Th +30/U +500 ppm	

USGS Data - In order of Geologic Occurrence – Bastnasite, HRE Laterite, Monazite, Apatite

*Selected Florida Phosphate with the lowest RE content and highest content.

**Heavy RE distributions range from 30% to 60% (not reflective of selected phosphates above)

There is no shortage of Rare Earths

Research conducted by The Florida Industrial & Phosphate Research Institute and USF confirms that the Phosphate mining industry in Florida dumps about 22,600 tons of rare earths* every year – due to Thorium content.

Assuming a 50% recovery, Florida alone could cover nearly 100% of current U.S. rare earth requirements.

Poul Emsbro, with USGS, estimates that the U.S. Phosphate Industry can supply up to 65% of global rare earth demand



FIPR Institute

January 4, 2012

Mr. James Kennedy
Th.REE-M3 LLC
P.O. Box 410380
St. Louis, MO 63141

Dear Mr. Kennedy:

Thank you for your inquiry about the potential for Rare Earth Element (REE) production as a byproduct of Phosphate mining. Research on this issue was recently conducted by the Florida Industrial and Phosphate Research Institute, University of South Florida Polytechnic.

On an aggregate basis the total potential for recoverable REE resources from phosphate mining in Florida is around 22,600 tons per year. These numbers are based on annual production of about 20 million tons per year of phosphate rock product analyzing 700 ppm REE, and 20 million tons each of sand tailings and waste clay at approximately one third of the REE concentration in the rock product. A 50% recovery rate would equate to nearly 100% of current U.S. demand.

Low mineral concentrations do not present an insurmountable economic impediment to recovery because there are no direct mining costs associated with the Rare Earths. Furthermore, as a result of the high specific gravity of the mineralization low cost gravitational separation is possible within, and/or, at the end of the normal beneficiation process.

The old phosphate waste clay associated with historical mining operations is another potential source for REE. According to a 1989 study by Mobile Research, waste clay contained as much as 336 ppm of REE. Florida has accumulated over a billion tons of such waste clay, making this one of the largest heavy rare earth deposits in the U.S.

Some of these Rare Earths in Florida phosphate are associated with Thorium and Thorium's current regulatory status and complete lack of markets creates a liability that may exceed the economic value of these resources. Something needs to change.

Making regulatory changes and developing markets and uses for Thorium is one of the keys to unlocking these valuable resources for Florida and the United States. I appreciate your efforts in this, and hope this information is of use to you.

Best regards,

A handwritten signature in black ink, appearing to read 'Patrick Zhang'.

Patrick Zhang, Ph.D.
Research Director - Beneficiation & Mining

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Estimated Rare Earth Resources Available From Active Mineral Sand Mining Operations In The U.S.

It is estimated that current mineral sands production in the U.S. can supply approximately 5K tons/year of monazite with low capital upgrade costs (<\$10M) and within a short timeframe (6 - 12 months). Expansion of current production could produce an additional 5K tons/year of monazite. Expansion opportunities could be brought online in 12-18 months and would involve more significant capital expenditure.

Estimates Produced by Adam Karst, P.G., President and Principal Geologist of Karst Geo Solutions, LLC, an independent consultant providing expertise to the mineral sands industry

China's state sponsored monopoly represents a clear case of "market failure" for the U.S. and other nations

Historically, all capitalist economies resolve "market failure" with the same economic tool: a Cooperative.

Cooperatives utilize shared capital to establish economies of scale and minimize risk by coordinating the interests of producers and consumers

Multi-National Rare Earth Cooperative

Completely Insulated From Chinese Monopoly Pricing



REEs from Coal



Multiple RE Suppliers – RE is currently treated as waste



RE Refinery Co-op / oxides, metals, alloys, non-IP magnets, etc.

Thorium liability



The Th-Bank assures that Thorium is no longer released into the environment



Thorium Bank holds all Actinide liabilities and acts as a multi-national platform for the international development of Thorium energy systems & other industrial uses for Thorium

The Cooperative is Funded by Owner-Operators-End-Users

Japanese, EU & U.S. Technology Companies

N.A.T.O Member States

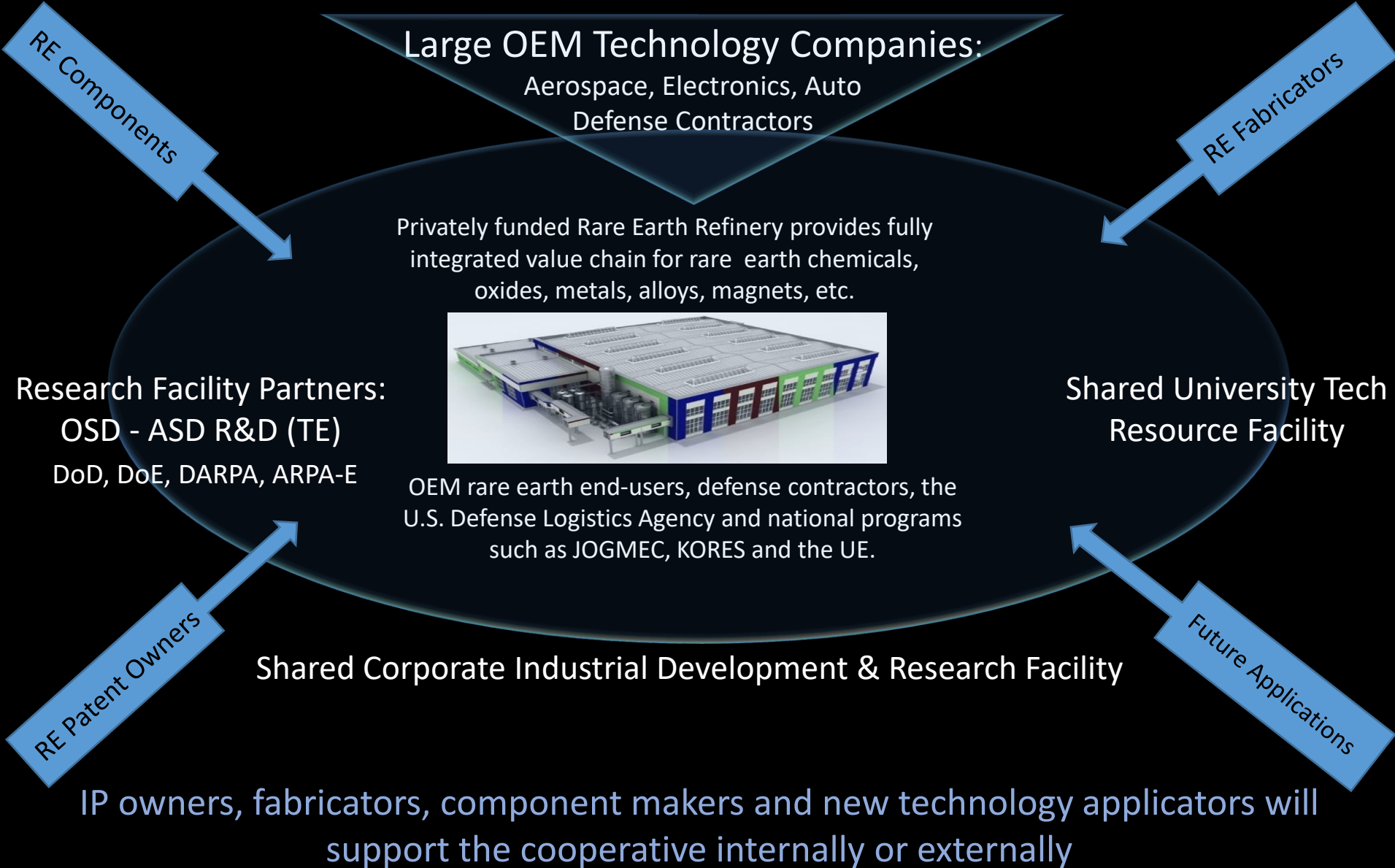


U.S., Japanese, EU & other Government Entities



RE end-users own/control the Co-operative and are guaranteed proportional off-take 'at cost'.

Centralized Th-Bearing Rare Earth Refinery Cooperative



All environmental risks are resolved by transferring the resulting actinides to a “Thorium Bank”

The current alternative is that these materials are released back into the environment – into permitted tailings containment areas (including MP Mine) or blended back into the depleted resource area

The Thorium Bank eliminates all downstream contamination risks and would comply with all NRC and EPA regulations

The Thorium Corporation: Storage, Industrial Utilization & Energy

Safe Storage



Energy



Defense & Space Applications

Th Bank

Thorium Storage, Energy & Industrial Products Corporation



Industrial Uses



Computing & Electronics

Structural Materials



Energy Systems



Advanced Alloys

Thorium and all other Actinides will be transferred to the “Thorium Storage, Energy and Industrial Products Corporation”

DBA: The Thorium Bank

The Thorium Bank will act as a:

- 1) Strategic reserve for the safe storage of Thorium
- 2) Private corporation authorized by Congress to develop commercial
 - a) uses and markets for Thorium, including
 - i) non-energy, medical and industrial materials
 - ii) Thorium energy systems

Funded by U.S. & multi-national entities and sovereign governments

A significant part of our Nations defense systems are heavy RE dependent

Heavy RE Dependent Technologies

None of these are currently produced in the USA

Tb	Magnets, Lighting & Phosphors, Fuel Cells – Automotive, Wind Turbines, Defense Applications: Terfenol-D Sonar , Guided Ordinance, Lasers, Drones
Dy	Magnets, Nuclear Control Rods, Lasers – Automotive, Wind Turbines Defense Applications: Terfenol-D Sonar, Guided Ordinance, Drones, Stealth, Directed Energy
Ho	Magnets, Nuclear Control Rods, Lasers, Microwave Equipment Defense Applications: Rail Gun, Direct Energy Weapons, EMPs, Lasers
Er	Industrial & Medical Lasers, Fiber Optics, Nuclear Control Rods, EU Currency Defense Applications: Infra-Red CM, LADAR, Communications. Drones
Tm	Super Conductors, X-Ray, Industrial & Medical Lasers, Optic Display, EU Currency Defense Applications: Magnets, CTH YAG Lasers. Drones, Directed Energy
Yb	X-Ray, Optics, Steel Alloy, Stress Instrumentation, Solar Cells, Lasers Defense Applications: Advance Photonics Phase-Lock Array Lasers, Drones
Lu	Nuclear Dating, Metal Alloys, Catalysts, Medical Imaging and Treatments Defense Applications: Active / Passive Infra Red Cameras, Scintillators, Directed Energy
Sc	Supper Aluminum Alloys, Specialty Lighting, Lasers, Fuel Cells Defense Applications: Air Frame Alloys and Missile Hardening
Y	Phosphors, Electrodes, Super Conductors, Lasers, Catalysts Defense Applications: Guided Ordinance, Lasers, Communication, Radar, Super Alloys

Under the current environment the problem is grossly exacerbated because MP Mine sends all of its valuable REs to China. The U.S. becomes a supplier to its adversaries monopoly