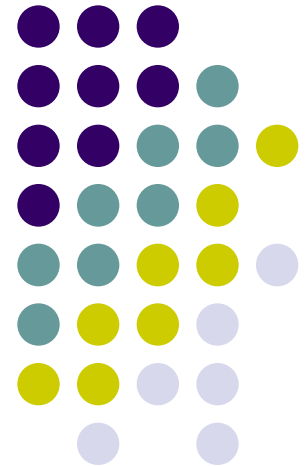


# Rare Earth Supply and National Security & Clean Energy

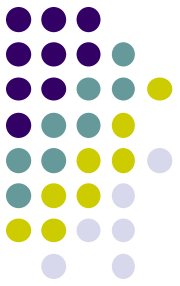
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TREM 10  
Understanding the Fundamentals  
Hilton Washington Embassy Row  
March 17, 2010

Keith A. Delaney  
Executive Director  
Rare Earth Industry and Technology Association  
(REITA)

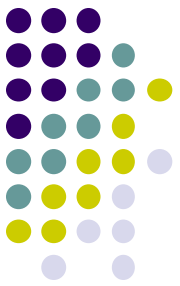


# National Security / Clean Energy Overview



- RE applications for defense and Green Energy initiatives are truly critical
- Supply chains for these technologies are already at risk and supply disruptions are likely
- China has little or no incentive to continue to support supply chains outside of its own borders

# What Are the Rare Earth Elements?



H																	He	
Li	Be											B	C	N	O	F	Ne	
Na	Mg											Al	Si	P	S	Cl	Ar	
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
Cs	Ba		Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
Fr	Ra		Rf	Db	Sg	Bh	Hs	Mt										
		La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
		Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		

# REE Terms



## Light REE (LREE or “Lights”) – La through Gd

- Pr, **Nd**, Sm for RE *permanent magnet* electric motors and generators
- **Eu** for optical applications

## Heavy REE (HREE or “Heavies”) – Tb through Lu plus Y

- **Dy** for thermal stability of RE *permanent magnets*
- **Tb** and **Y** for optical applications especially for *advanced lighting* like CFLs and LEDs

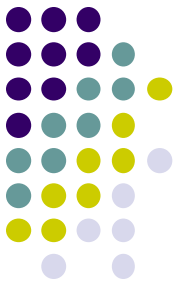
# Where Do RE Come From?

## Global RE Production



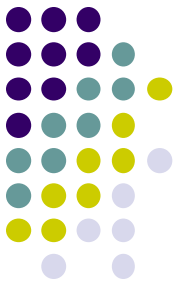
	2008 (mt REO)	2012f (mt REO)	2014f (mt REO)
<b>China</b>	115,000	145,000	165,000
<b>Baotou</b> , Inner Mongolia	~ 55%		
<b>Sichuan Province</b>	~ 35%		
<b>Southern Ionic Clays</b> (only global source for <b>Heavies</b> – Tb, Dy, Y)	~ 10%	<b>How much for export ?</b>	<b>How much for export ?</b>
<b>Rest of World</b>	9,000	20,000	38,500
India	x	x	x
Russia / Estonia	x	x	x
<b>US (Molycorp)</b>	0	<b>X</b>	<b>XX</b>
<b>Australia (Lynas)</b>	0	<b>X</b>	<b>XX</b>

# Characteristics of REE



- Found together in nature
- Chemically similar
- Difficult to process and separate
- Able to readily give up or accept electrons leading to enabling performance attributes in magnetics, optics, electronics and photonics

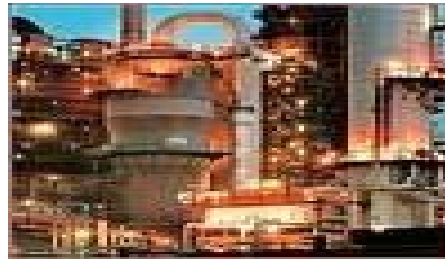
# Historic Applications for RE Have Staying Power



MRI

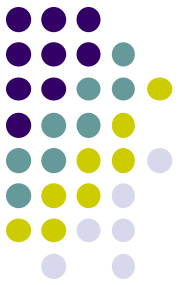





FCC Unit



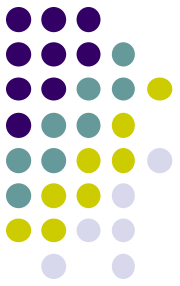
Catalytic Converter




# Emerging Clean Energy Applications Will Drive RE Market Growth



	<b>Application</b>	<b>Rare Earth (RE) Technology</b>	<b>Enabling Functionality</b>	<b>RE Elements Required</b>
 <p>Toyota Prius</p>	Hybrids, Plug-In and All Electric Vehicles	RE Permanent Magnets	Electric Traction Drives replacing or supplementing internal combustion engines	Nd, Pr, Dy, Tb
 <p>Bosch Electric Power Steering System</p>	Electric assist motors in conventional and advanced vehicles	RE Permanent Magnets	Higher MPG by taking significant loads off power trains	Nd, Pr, Dy, Tb
	Integrated Starter / Generator for Improved MPG	RE Permanent Magnets	Shuts off engine when stopped and instant restart when accelerator is pressed	Nd, Pr, Dy, Tb

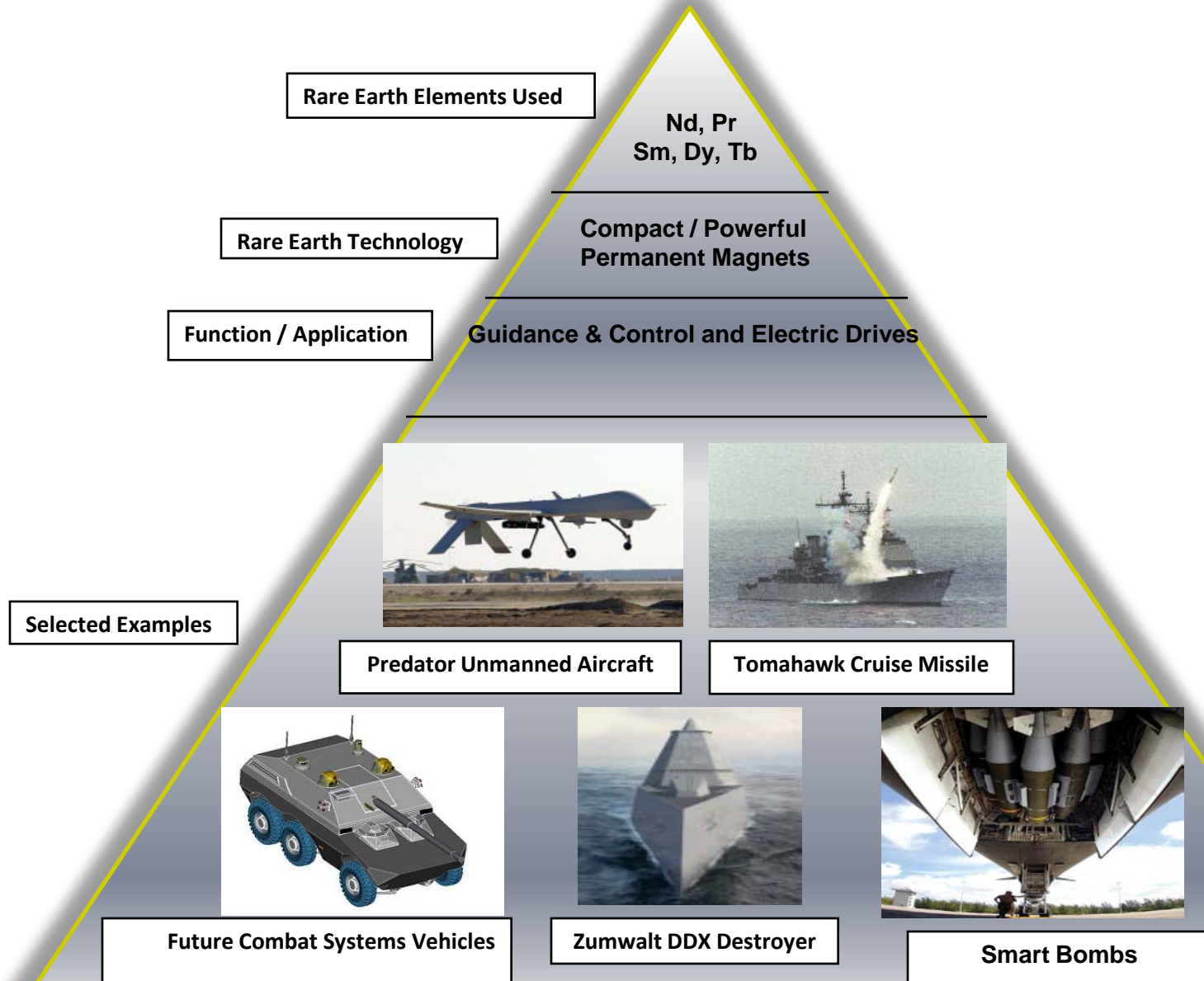
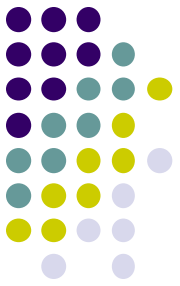
# Emerging Clean Energy Applications Will Drive RE Market Growth



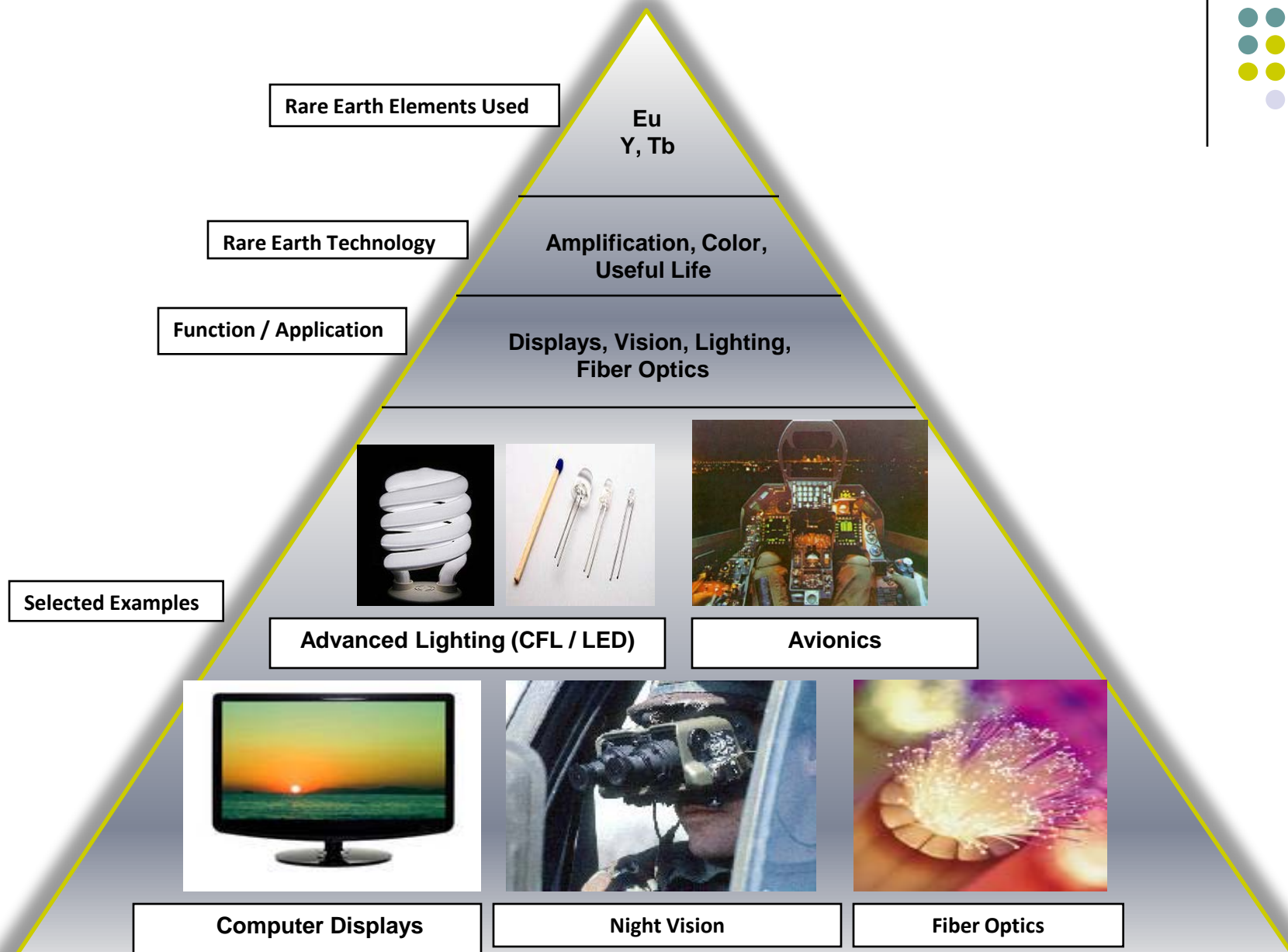
	Application	Rare Earth (RE) Technology	Enabling Functionality	RE Elements Required
 <p>High power Ni-MH Battery from Toyota Prius</p>	Ni Metal Hydride Batteries	Energy Storage	Proven and Cost Effective compared to Li Ion Battery alternatives	La, Ce
	Compact and Linear Fluorescent Lamps	RE Phosphors	Ability to match color and brightness of incandescents with 70% less energy	Y, Eu, Tb
	Wind and Hydro Power Generation	RE Permanent Magnets	Gearless generators for better reliability and online performance	Nd, Pr, Dy, Tb

**Demand Wild Card**

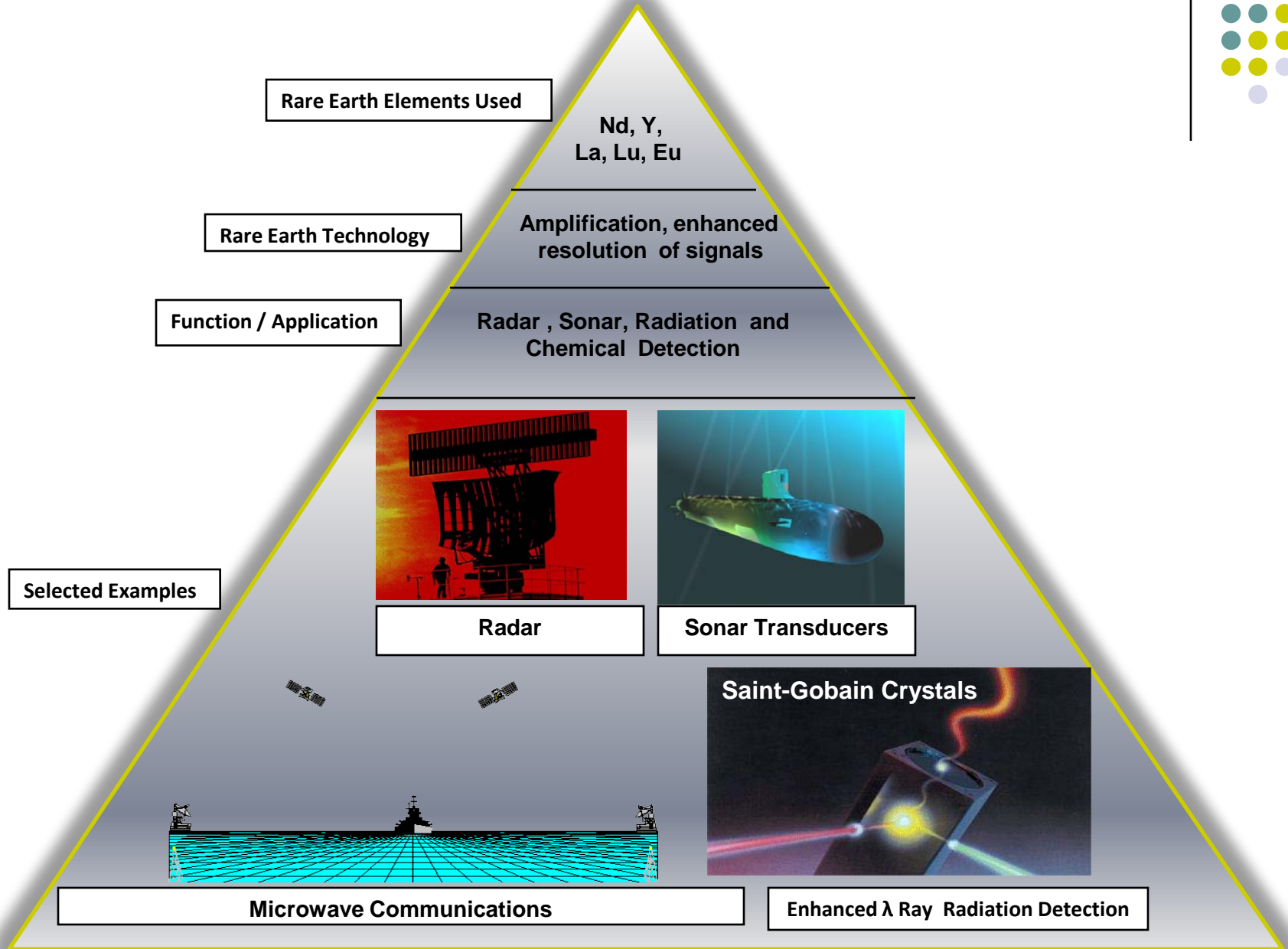
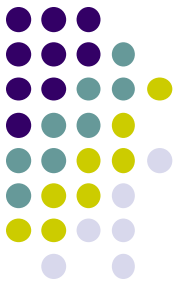
# US Department of Defense Interest in RE Technologies



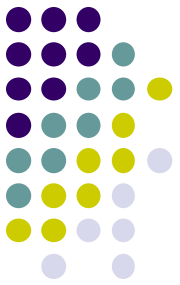
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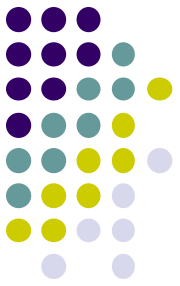


# Chinese Motivation



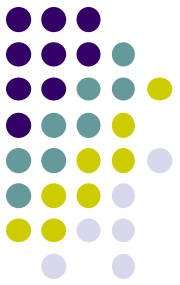
Observation	Consequence Related to RE Industry
<p>China <i>recognized the strategic value of its RE resources</i> long before the days of Deng Xiaoping.</p> <p>With skill, patience and investment <i>China has transformed the Rare Earth industry</i> into what it is today.</p>	<p>Government support of advanced curricula in RE sciences has produced <i>thousands of technical professionals employed</i> in RE industry today.</p> <p>China has been instrumental in the development of many new / high tech applications which has helped <i>quadruple the size of the RE market since 1990.</i></p> <p><i>100%</i> share of global market <i>for RE metals</i> (97% share of global market for REO).</p>

# Chinese Motivation



Observation	Consequence Related to RE Industry
<p>China realizes it has to improve the management of its RE resource with <i>focus on conservation, higher overall yields and environmental protection.</i></p>	<p><i>Controls employed</i> to date include: production limits, export quotas, export tariffs, stockpiling, closing of separation plants and even literally blowing up “illegal” mines.</p>
<p><i>Chinese economy will continue to grow</i> at or near double digit rates for the foreseeable future</p>	<p><i>Disposable income</i> for automobiles, personal electronics, etc. <i>driving significant internal RE demand.</i></p> <p>China is already the largest auto market and will produce 500,000 electric vehicles in 2011.</p> <p>Leads in wind power generation</p>

# Chinese Motivation

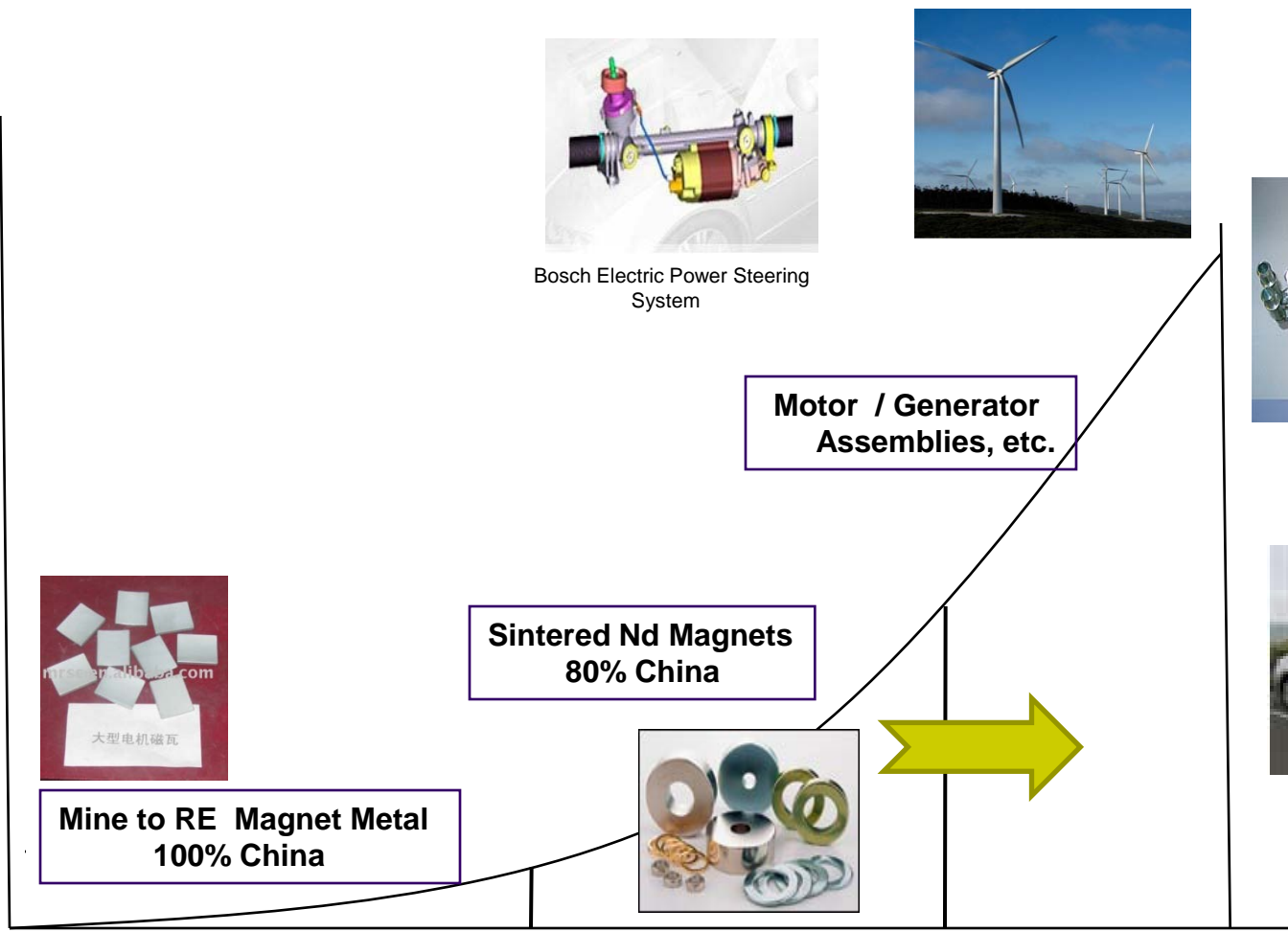


Observation	Consequence Related to RE Industry
<p><i>China must create 300 million jobs within the next 10 years</i></p>	<p>The Chinese will continue to manage its RE virtual monopoly to <i>induce downstream (value add) manufacturing to relocate to China.</i></p>

# Where Are the Jobs in the RE Magnet Motor Supply Chain?

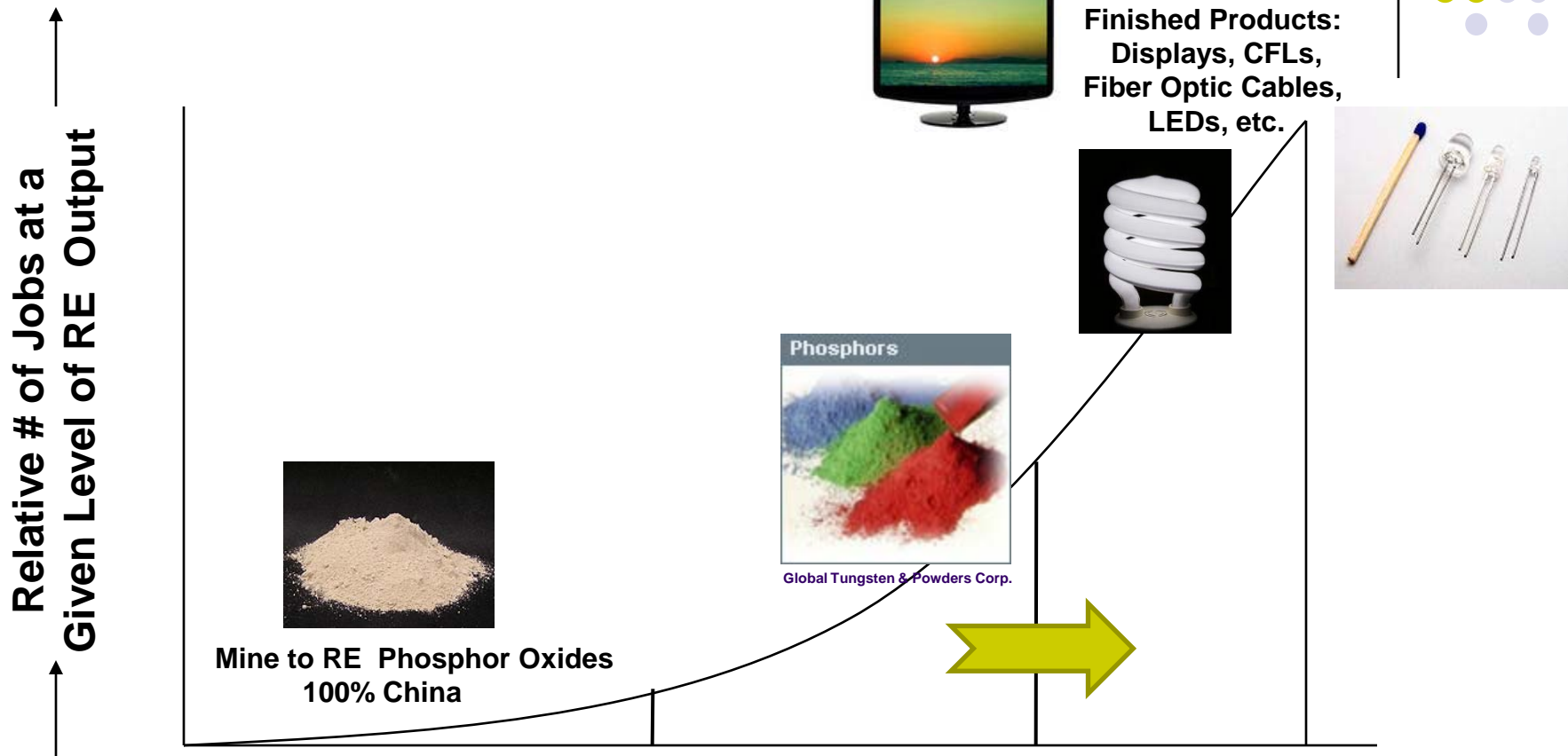


Relative # of Jobs at a Given Level of RE Output



Mine to Motor Assembly Supply Chain

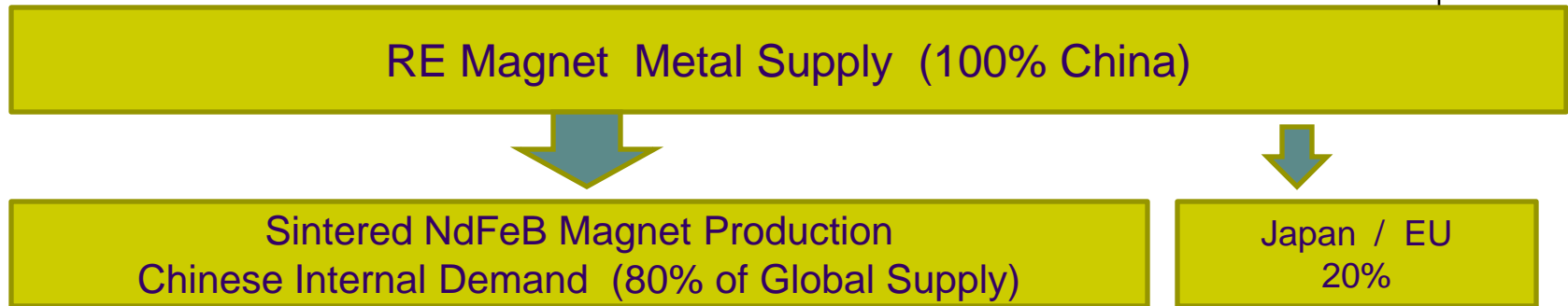
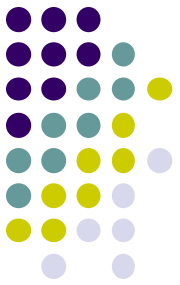
# Where Are the Jobs in the RE Phosphors Supply Chain?



Mine to Optical Applications Supply Chain

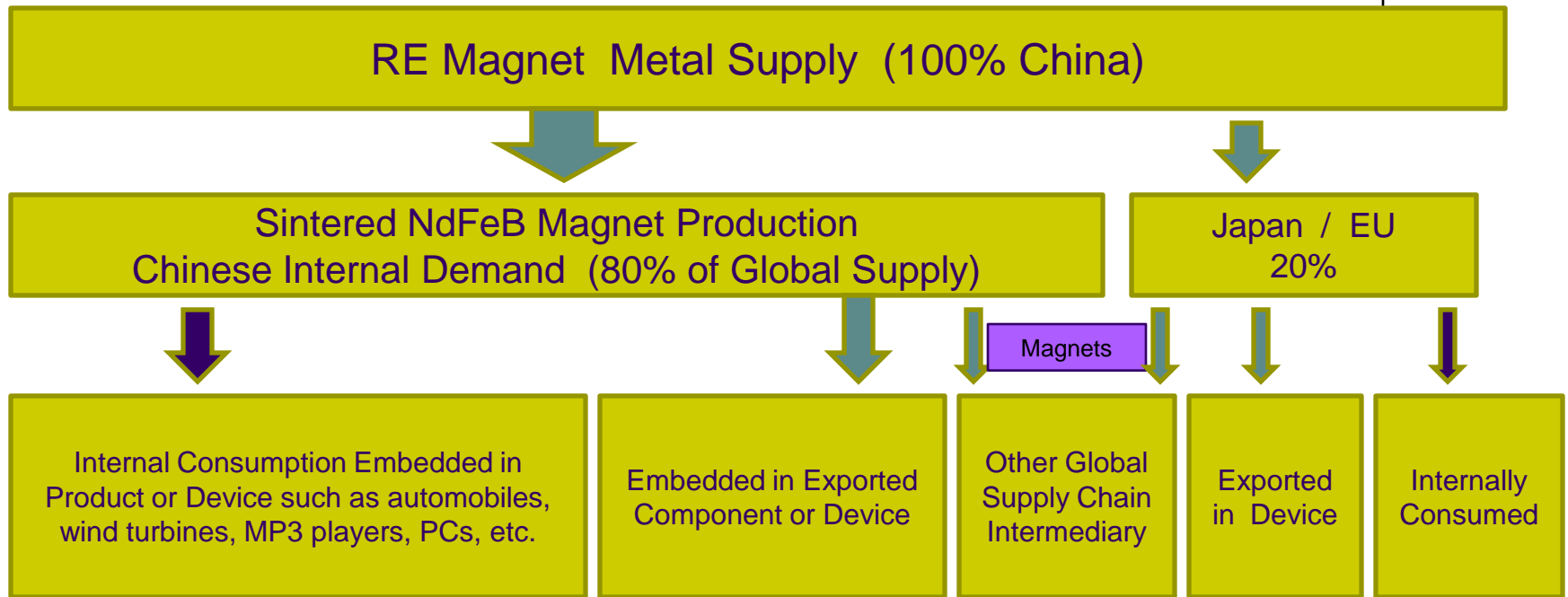
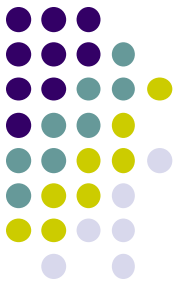
# How Does the US Military Obtain Its RE Permanent Magnets?

(same applies to commercial OEMs)



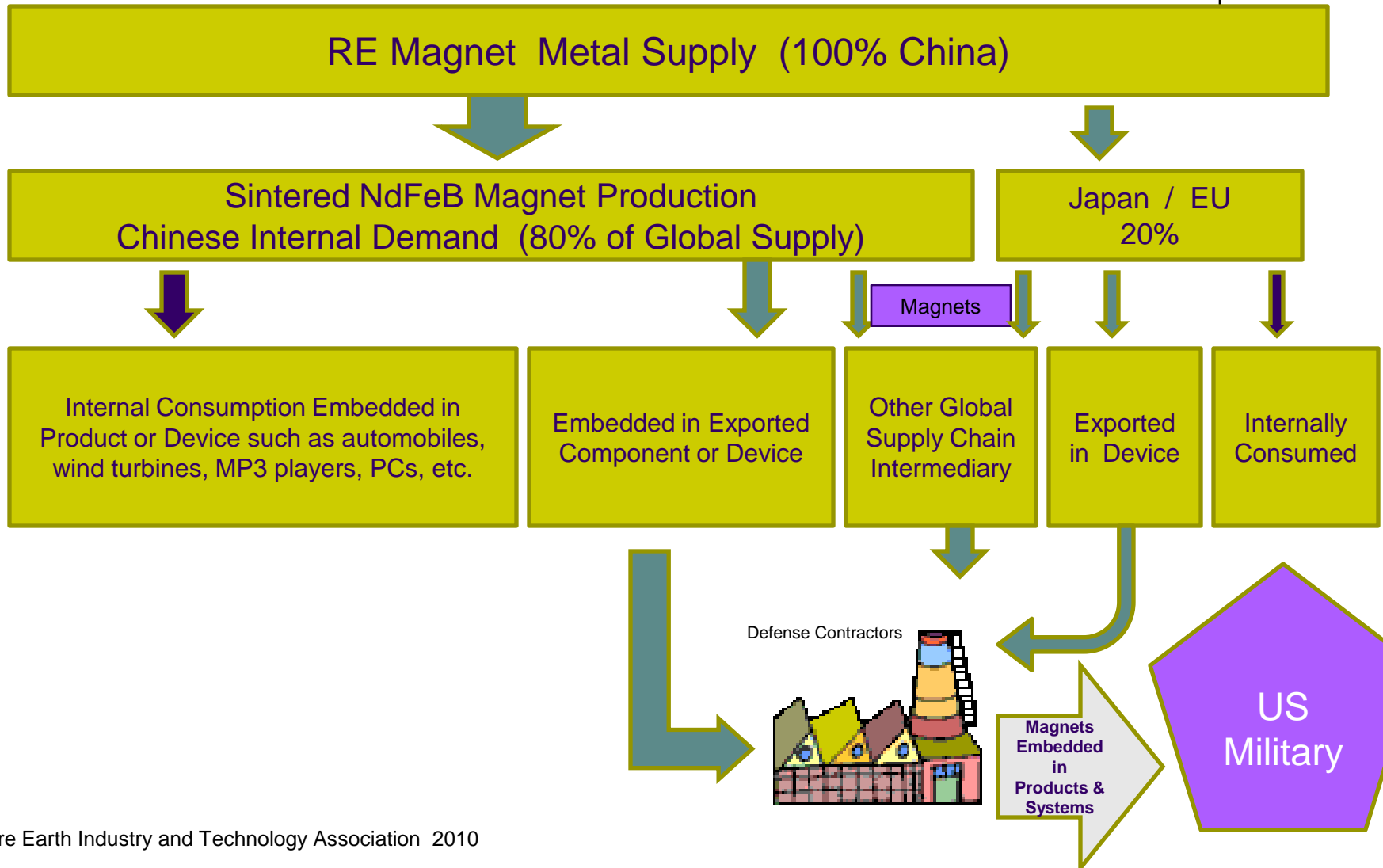
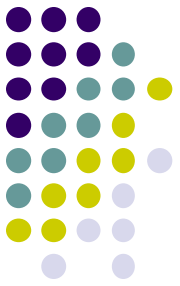
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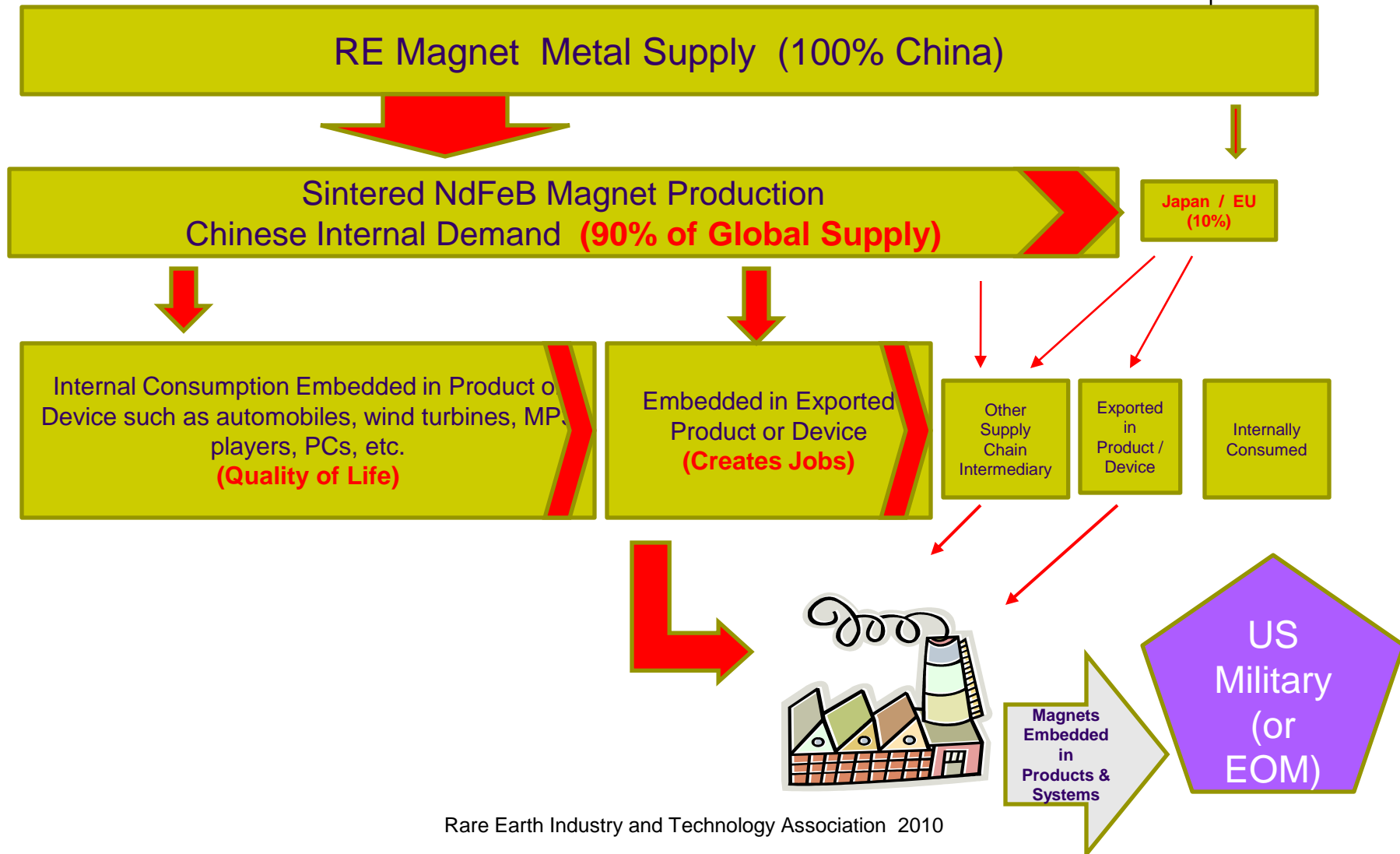
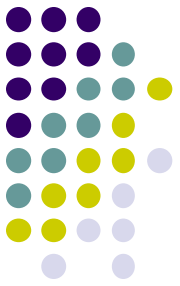


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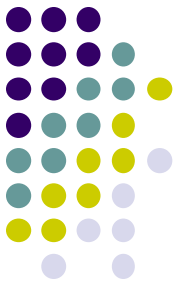
# Export of Chinese RE Materials Shrink in a Supply Disruption





# Conclusions

- RE applications for Defense and Green Energy initiatives are truly critical
- Supply chains for these technologies are already at risk and supply disruptions are likely
- China has little or no incentive to continue to support supply chains outside of its own borders
- Urgent action by stakeholders is required to address this vulnerability by creating globally diverse and competitive supply chains



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# REITA

Rare Earth  
Industry and  
Technology  
Association

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*Tomorrow's Technology Today*