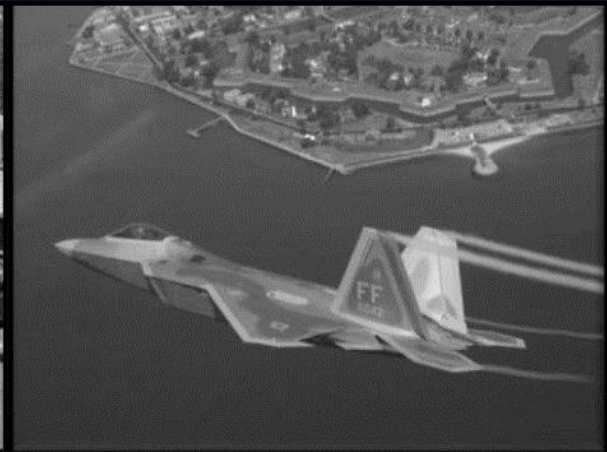




DEFENSE LOGISTICS AGENCY

AMERICA'S COMBAT LOGISTICS SUPPORT AGENCY



Economic Drivers of Strategic & Critical Materials

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Report Documentation Page				Form Approved OMB No. 0704-0188	
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.					
1. REPORT DATE MAY 2012		2. REPORT TYPE		3. DATES COVERED 00-00-2012 to 00-00-2012	
4. TITLE AND SUBTITLE Economic Drivers of Strategic & Critical Materials				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Defense Logistics Agency, Strategic Materials, 8725 John J Kingman Road, Ste 3229, Fort Belvoir, VA, 22060-6223				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Presented at the NDIA Environment, Energy Security & Sustainability (E2S2) Symposium & Exhibition held 21-24 May 2012 in New Orleans, LA.					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 25	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



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Overview - Megatrends

- Major “disruptions” to the global economy and social fabric have implications for material requirements
- Examples:
 - Miniaturization and Light-weighting
 - Processing speed
 - Social Networking
 - Additive “social” manufacturing
 - Greening of the economy



Miniaturization & Light-Weighting



Weight: 2.5 lbs

Dimensions: 9" x 5" x 1.7"

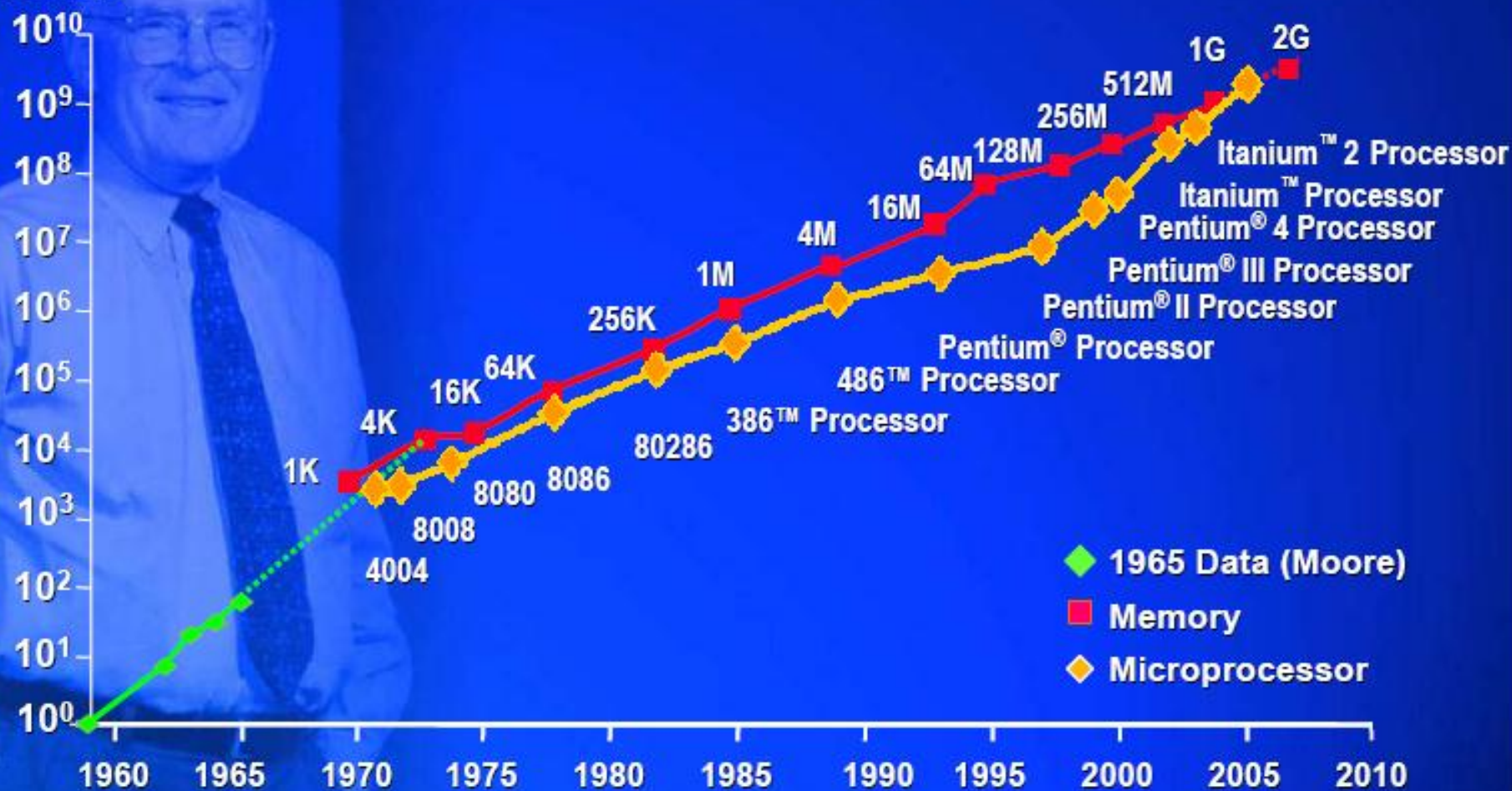


Weight: 140 grams

Dimensions: 4.33" x 2.36" x .27"

Moore's Law - 2005

Transistors
Per Die





Social Networking





Greening of the Economy





Implications for Technological Change

- Change the way society is organized
- Affect the way we interact with one another
- Transform the way we do business
- Alter the way we take part in leisure
- Have profound impact on access to information
- Can be a force for democracy and openness
 - And also their opposites
- Alters the way humans perceive what is “current”



Some Variables that Matter

1. Growth rate of the material's end-uses
2. Intensity of use (e.g. quantity per person, quantity per dollar)
3. Availability and performance of substitutes
4. Technology deployment and penetration
5. Scale-up
6. Import vulnerability
7. Parent/Daughter metals
8. Market concentration
9. Social, political, environmental, regulatory and governance
10. Crustal abundance and form of mineralization
 1. Cost of exploration and extraction
11. Energy costs
12. Business strategy

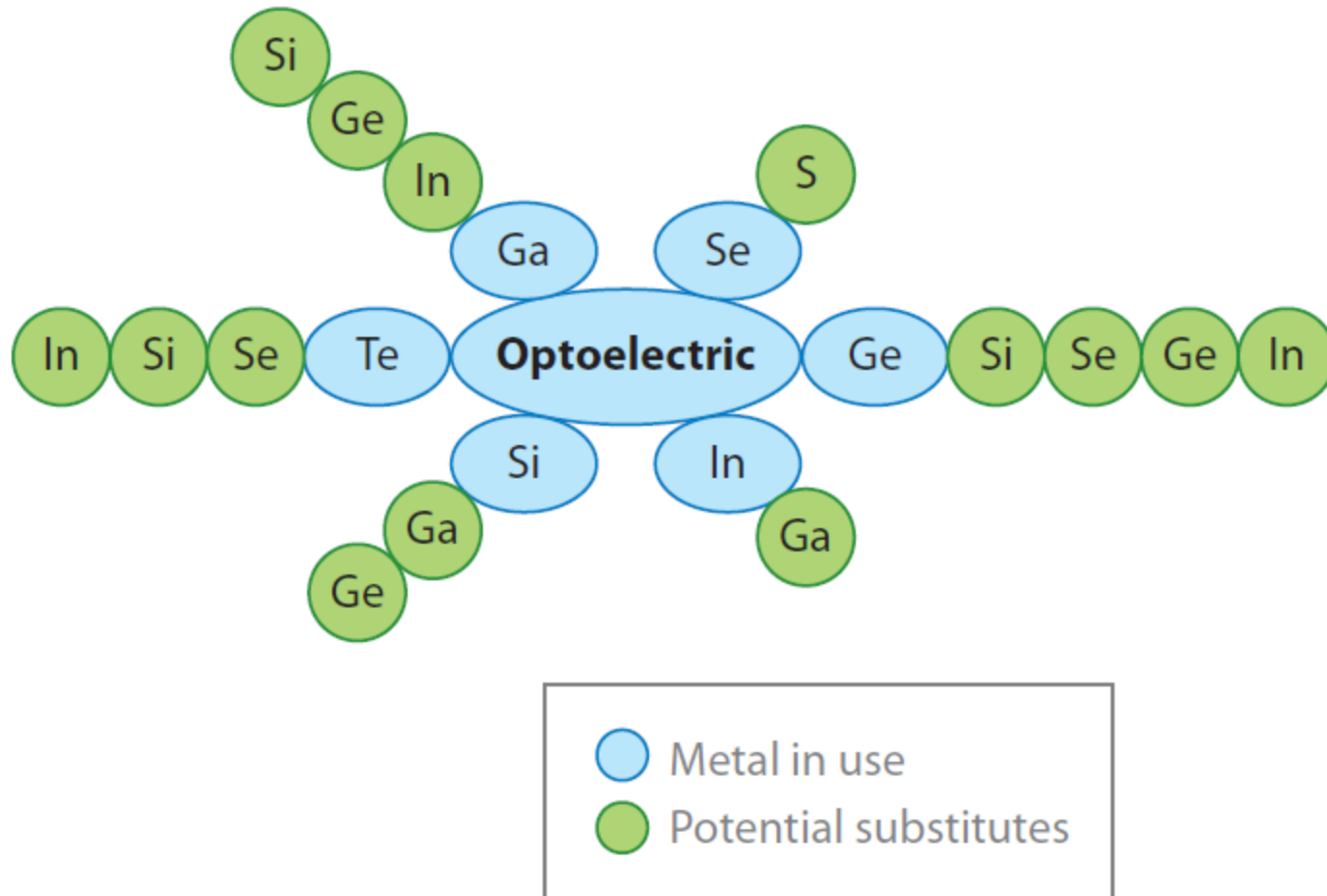


Substitutes

- Many high tech materials lack readily available, cost-effective substitutes
 - And typically are daughter elements of the existing parent element currently in use
- Substitution often requires re-engineering of not only the product but the entire supply chain
- Substitution requires re-testing and re-certification
- Substitution is expensive and is best thought of a long-term solution requiring significant R&D expenditure
 - But, we can't just wait for the long-term to arrive. Successful companies are acting now so substitute materials are researched, tested, and commercialized

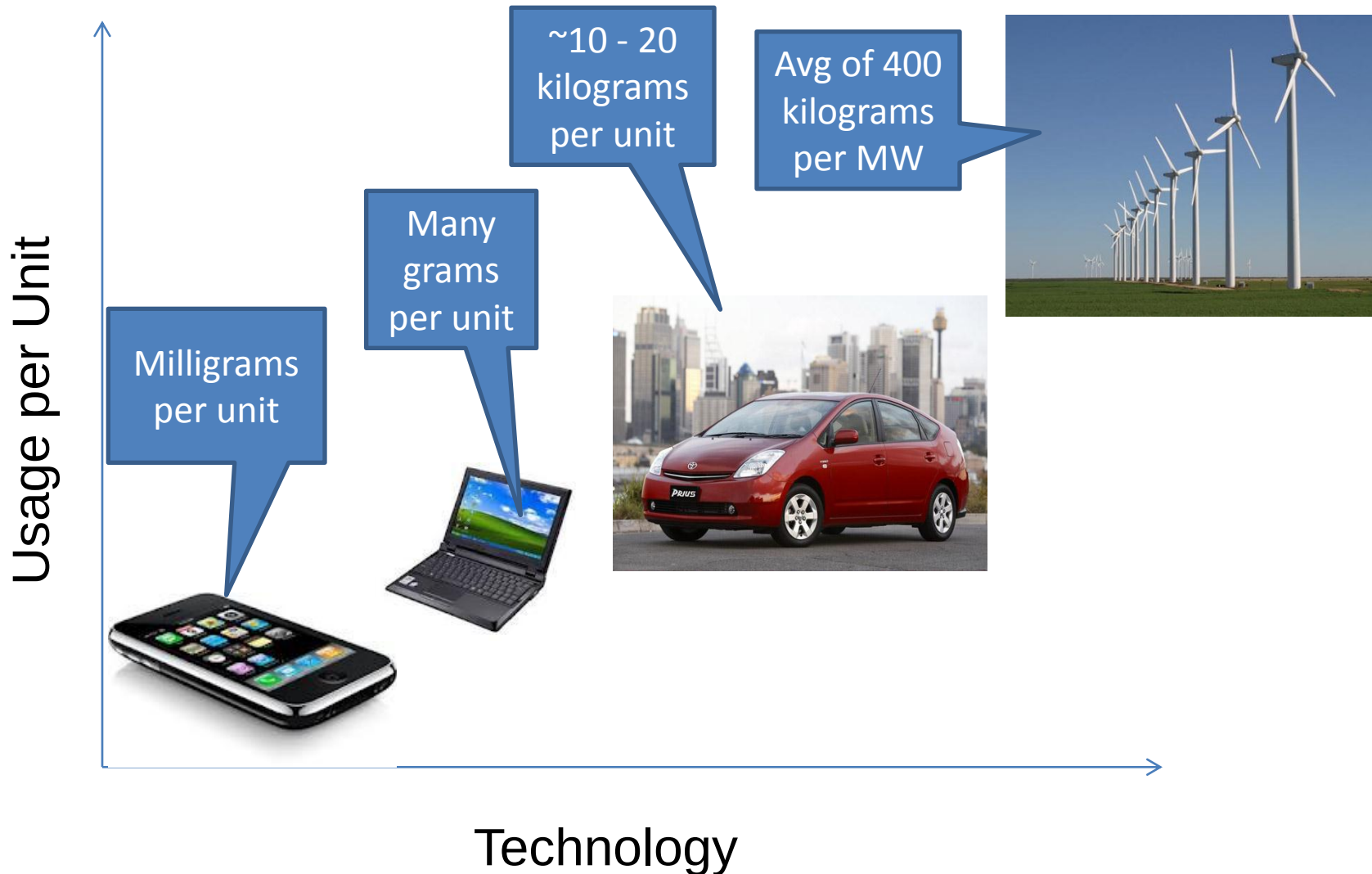


The Flower of Potential Substitution Involves Supply Issues of Their Own





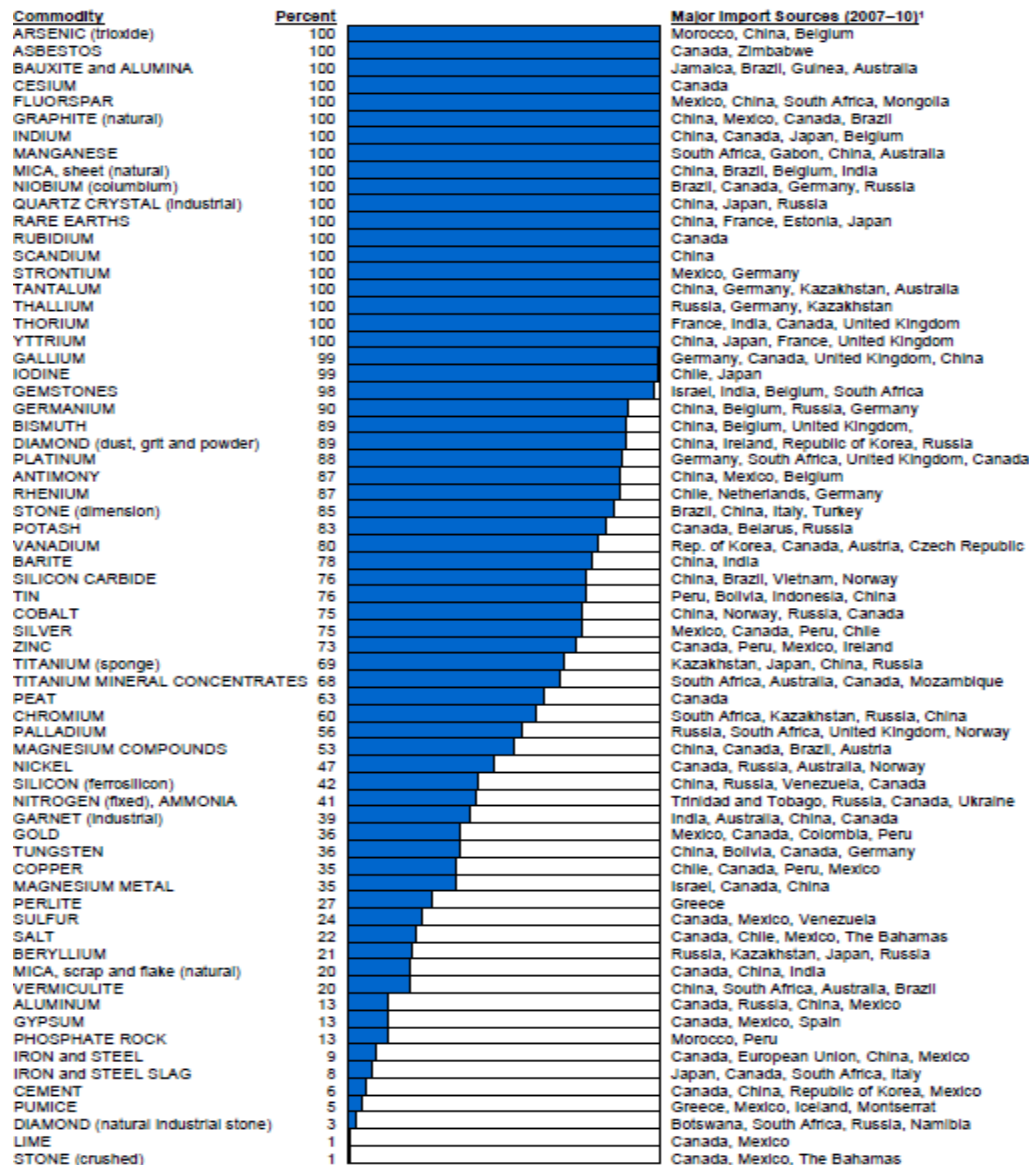
Rare Earth Scale-up Example





USGS Import Dependence - 2011

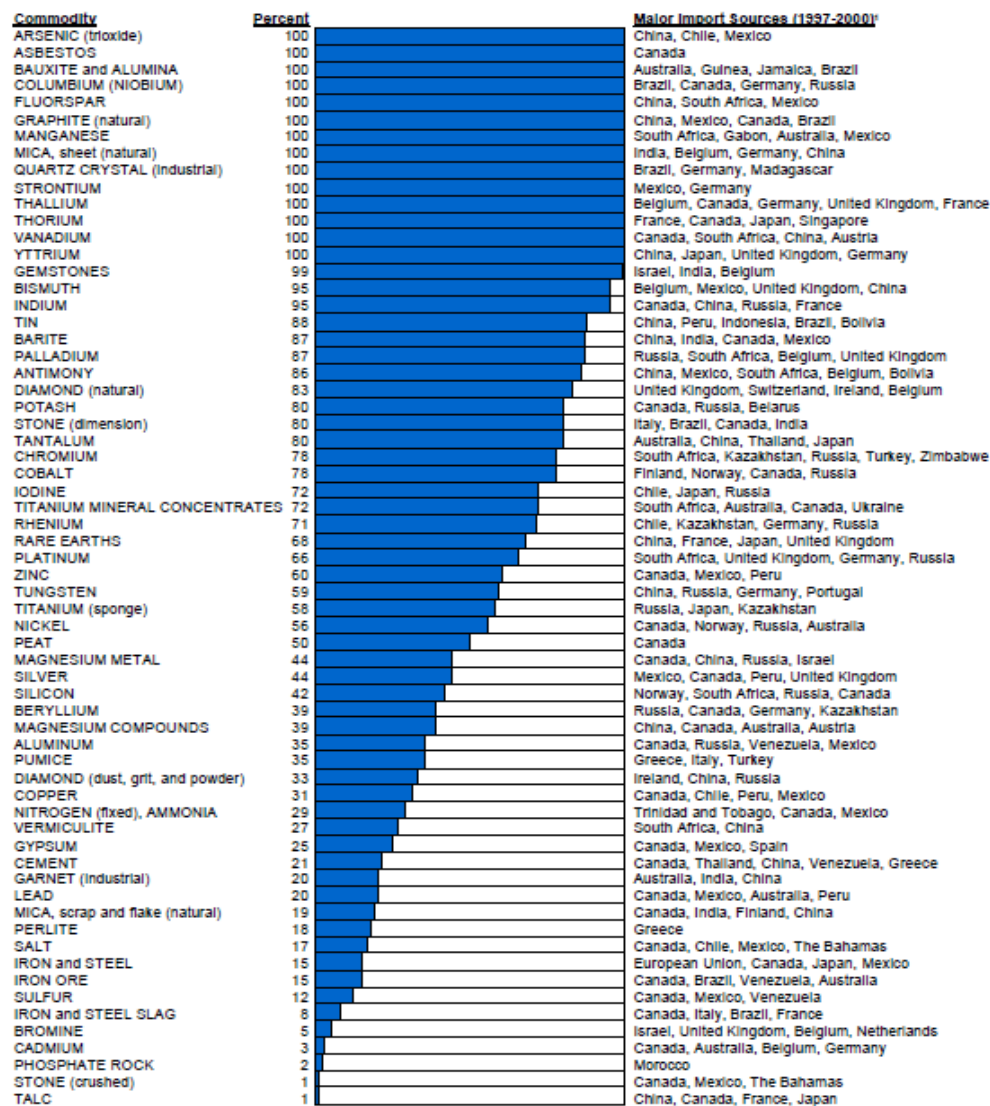
2011 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS





USGS Import Dependence - 2001

2001 U.S. NET IMPORT RELIANCE FOR SELECTED NONFUEL MINERAL MATERIALS



*In descending order of import share



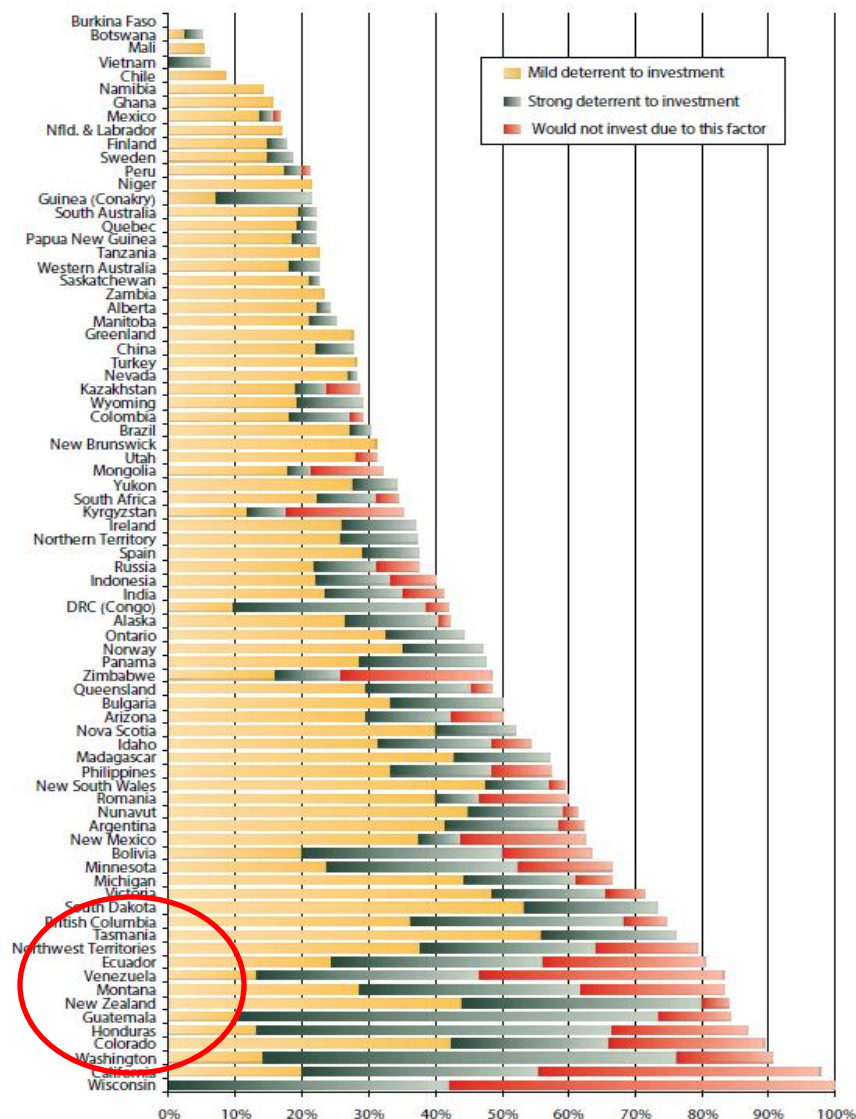
Dependence vs. Vulnerability

- Relatively higher risk of supply disruption due to uncertainty over the rules
 - Regulations
 - Taxes and royalties
 - Property rights and basic rule of law
- Relatively higher risk of industrial action, labor action or nationalization
- Technology transfer and loss of know-how
- Loss of key links in the middle of the supply chain
 - The U.S. has mineral wealth, it just chooses to limit its use
 - Policy-driven or basic economics?



Fraser Institute Policy Potential Index 2010/2011: Some U.S. states are not friendly to Mining

Figure 6: Uncertainty concerning environmental regulations

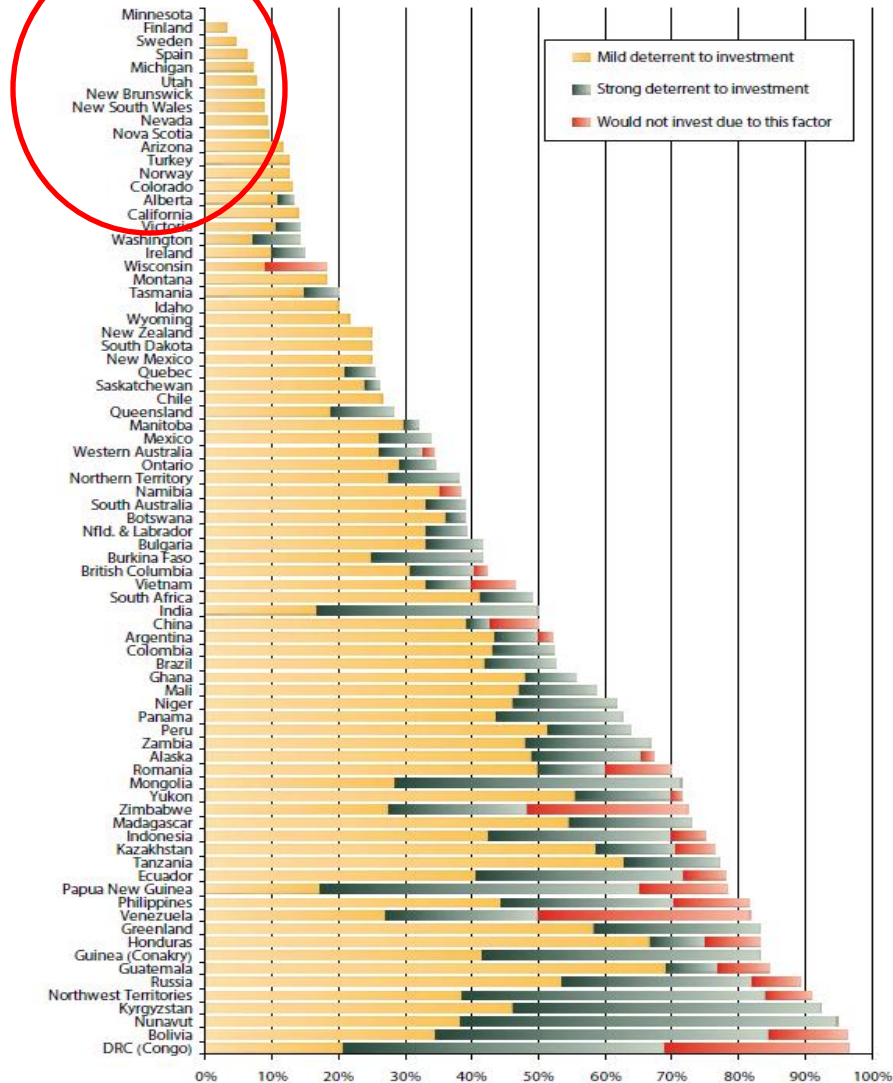




Fraser Institute Policy Potential Index

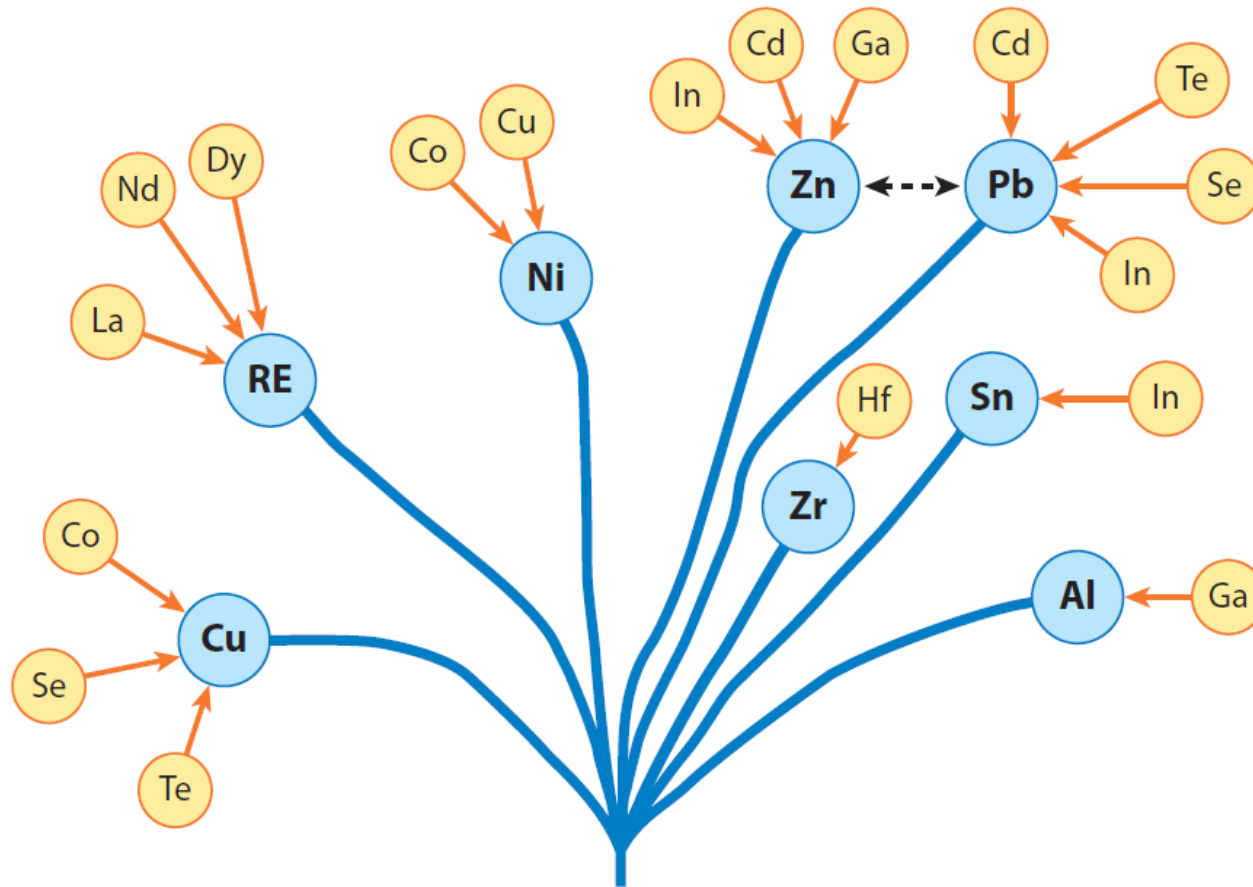
2010/2011: U.S. Fares Better in Land Issues

Figure 12: Infrastructure (includes access to roads, power availability, etc)





Parent/Daughter Metals Complicate Economics



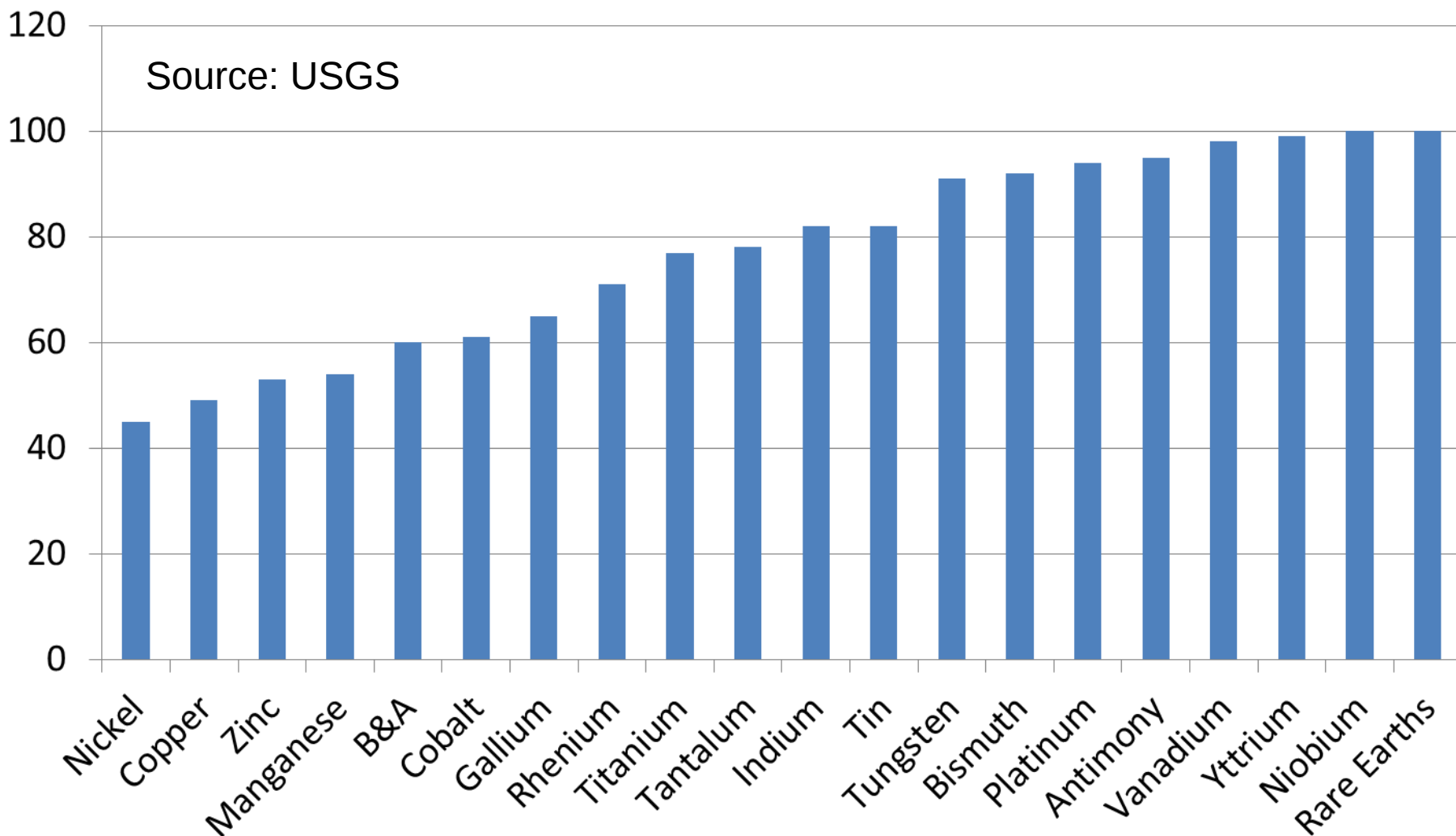


Market Concentration

- Typical measures
 - Herfindahl-Hirschman Index (HHI)
 - Concentration ratios
 - Share of world production
 - Share of U.S. imports
- Market share of top 3 supplier countries
 - Antimony – 94%
 - Bismuth – 90%
 - Niobium – 100%
 - Rare earths - ~100%
 - Rhenium – 68%
 - Zinc – 66%
- Companies that operate in highly concentrated markets can wield enormous power
 - Pricing
 - Intellectual property
 - Raw material negotiations
 - Barriers to entry



Market Share of Top 3 Producing Countries





Prices

- Serve as signals that allocate resources and reveal consumer preferences
- Are more transparent in exchange traded commodities such as LME and COMEX
- Spikes can show response to unusual supply disruptions, government policy or demand excursions
 - Political upheaval in the DRC in the 1990s (cobalt)
 - Supply disruption in 2007-2008 (silicon wafers, spot price)
 - Reduction of Chinese export quotas (rare earths)
 - Laptops (1996) and flat screens (2005) (indium)



Bringing it all Together

- The objective is to get some measure of risk
 - Importance to the industrial base
 - Vulnerability of supply
- Develop techniques to plot risk on a matrix
 - 2 dimensional
 - 3 dimensional (adding environmental risk to demand and supply risk)
 - Other dimensions?



Food for Thought

- Digital “additive” manufacturing
- 3-D printing
- Replication
 - Spare parts market
- China’s so-called labor cost “advantage”
- Carbon Fibers/Composites
- Viruses (the good kinds) and nanotechnology



Thank You!

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