

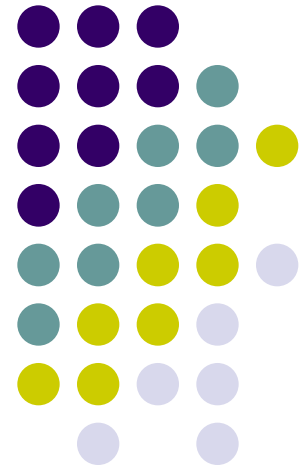
# Clean Energy Demand for Rare Earth Permanent Magnets



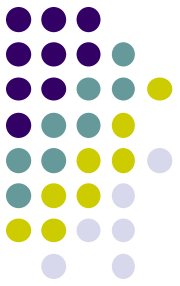
Keith A. Delaney

Executive Director

Rare Earth Industry and Technology Association



# REITA Update



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# REITA

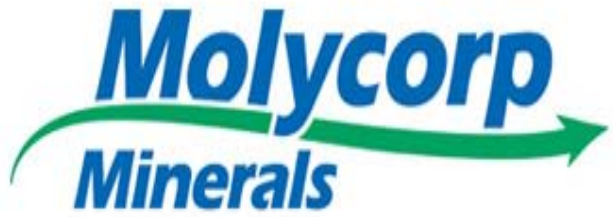
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Rare Earth  
Industry and  
Technology  
Association

*Tomorrow's Technology Today*



# REITA Members: RE Mining, RE Processing and Junior RE Properties



The Rare Earths Company



## Rare Element Resources

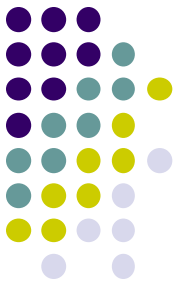


**GreatWestern**  
MINERALS GROUP LTD OTCQX: GWMGF



**GreatWestern**  
TECHNOLOGIES INC

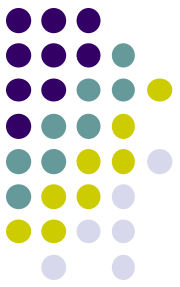
**LCM**  
less common metals



# REITA Members: RE Mining, RE Processing and Junior RE Properties



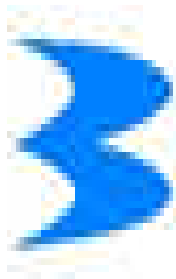
# REITA Members: Manufacturers of Rare Earth Magnets and Alloys



**ARNOLD<sup>®</sup>**

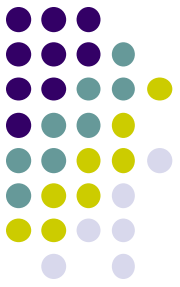
**MAGNETIC TECHNOLOGIES**

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**Santoku America, Inc.**

# REITA Members: Manufacturers of Rare Earth Phosphors for Advanced Lighting

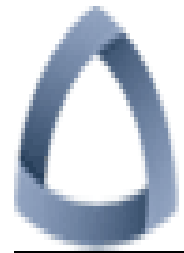


*Chemistry is our world, Responsibility is our way*

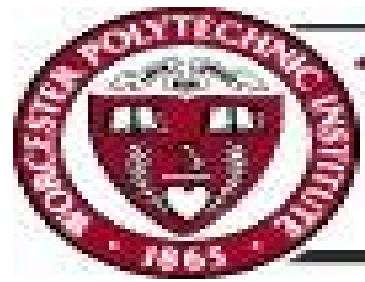




# REITA's Academic Members



**COLORADO SCHOOL OF MINES**  
EARTH ENERGY ENVIRONMENT



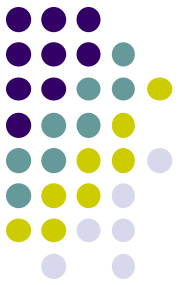
**WPI**

**IOWA STATE UNIVERSITY**  
OF SCIENCE AND TECHNOLOGY

*Iowa State University  
operates  
The Ames Laboratory  
under a contract with the  
U.S. Department of Energy*



# REITA Downstream Members

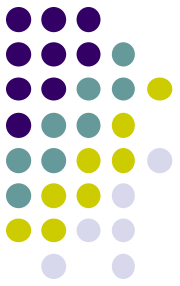


imagination at work



Manufacturer of PM Generators for Wind Turbines

# REITA's Newly Elected Board of Directors

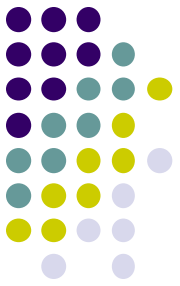


Dr. Steven Duclos – GE Global Research

Mark Smith – President & CEO Molycorp  
Minerals

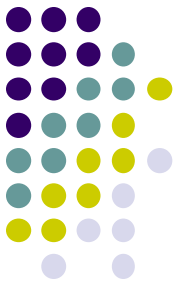
Timothy Wilson – CEO Arnold Magnetic  
Technologies

# REITA's Focus



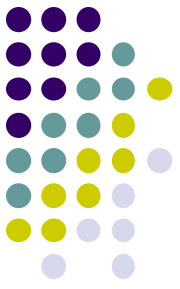
- Education / Information for all RE stakeholders
  - Establish REITA as “the *trusted source of unbiased RE information and analysis*” useful for the global stakeholder community as well as the general public”
  - ERESKU Initiatives
  - Provide information to government agencies
  - Active conference participant
- International membership growth
- OEM membership growth
- REITA does not lobby




# China Overview Assessment



Observation	Consequence Related to RE Industry
<p>China realizes it has to improve the management of its RE resource with <b><i>focus on conservation, higher overall yields and environmental protection.</i></b></p>	<p>The Chinese will continue to manage its RE virtual monopoly <b><i>to induce even more downstream (value add) manufacturing to relocate to China.</i></b></p>
<p><b><i>China must create 300 million jobs</i></b> within the next 10 years</p>	<p><b><i>China has no incentive to support supply chains outside of its own borders.</i></b></p>
<p><b><i>Chinese economy will continue to grow</i></b> at or near double digit rates for the foreseeable future</p>	<p>By 2015 <b><i>China could be a net importer of RE materials</i></b> just to feed their own Clean Energy needs</p>

# The Scale of Clean Energy Demand is Game-Changing for the Industry

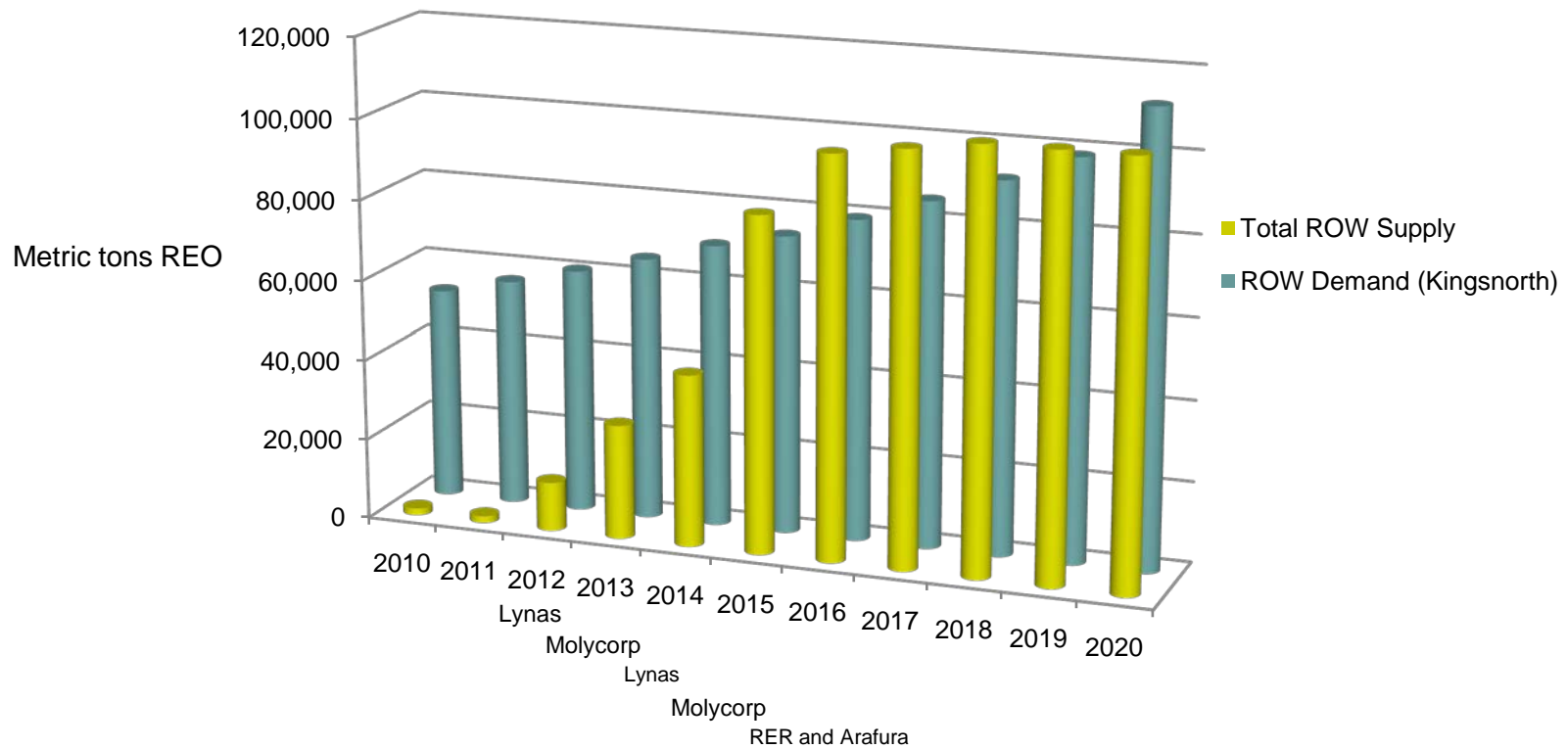
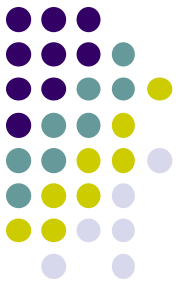


Applications		Typical Quantity of RE Oxides per unit
Traditional Markets i.e. disc drives, personal electronic devices, power tools, etc.		Grams
Hybrid and electric vehicles – direct drives and electric assist motors	 <p>Chevy Volt</p>	<b>Kilograms</b>
Direct Drive Wind Turbines		<b>Metric Tons</b>

# A Precarious Balance

## ROW 2010 – 2020 Supply / Demand Snapshot

(in collaboration with Dudley Kingsnorth)



# Can Additional RE Resources be Brought Online Seamlessly to Avoid the Disruption of Global Clean Energy Demand Initiatives?



Renewable Energy



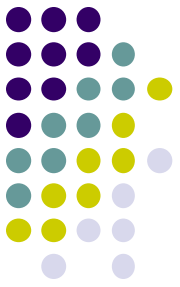
Electrified autos and other vehicles



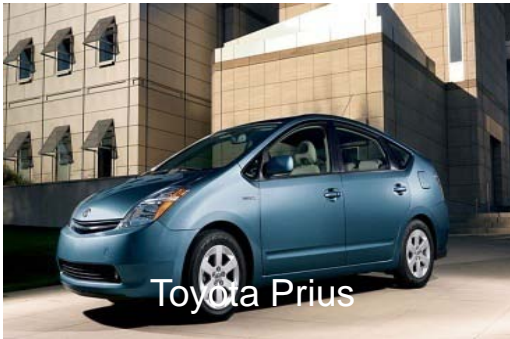
Advanced Lighting  
(Y, Tb, Eu, Gd)



# Clean Energy Demand Automotive



## Direct Drives in Hybrid, Plug-in Hybrid and All Electric Vehicles



Toyota Prius

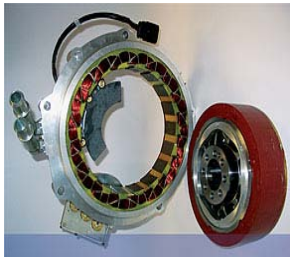


Chevy Volt

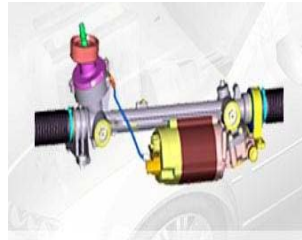


Nissan Leaf

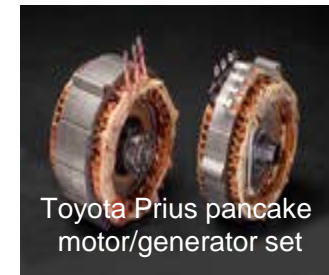
## Electric Assist Motors to Take Load Off Power Trains in ICE Vehicles



Integrated  
Starter/Generator



Bosch Electric Power  
Steering System



Toyota Prius pancake  
motor/generator set

Regenerative Braking

# Clean Energy Demand for PMG vs. Conventional Wind Turbines



Bigger is Better (Turbines over 1.5 MW require REPMG)

High efficiency at all wind speeds especially low and medium speeds where old technology is ineffective

Increased reliability – less downtime

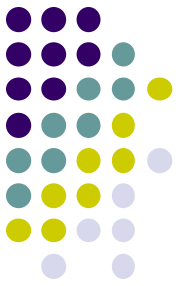
Maintainability – less maintenance

Grid integration



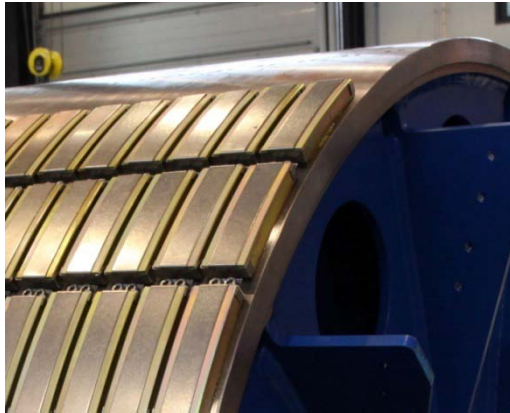
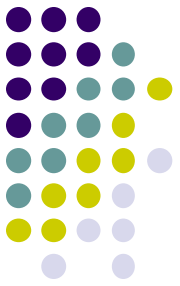
# 4 MW PMG

(The Switch)



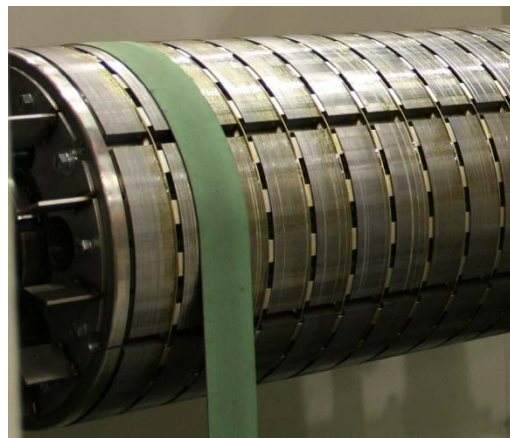
# PMG Magnet Arrays

(The Switch)



**Surface-mounted magnets for low and medium speed machines**

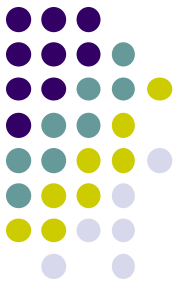
*Full excitation advantage of the magnets in low spherical speed machines.*



**Embedded magnets for high speed machines**

*Increased mechanical strength.  
Hermetically sealed; perfect protection.*

# Emerging Clean Energy Applications for Rare Earths We Haven't Discussed Yet



Off Road Vehicles



Electric Diesels



Electric Motor Scooters



JSF and More Electric Aircraft



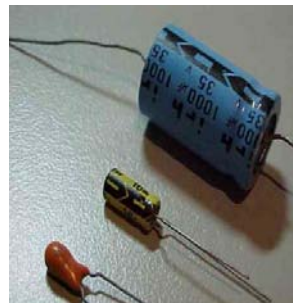
CHPS Future Combat Systems



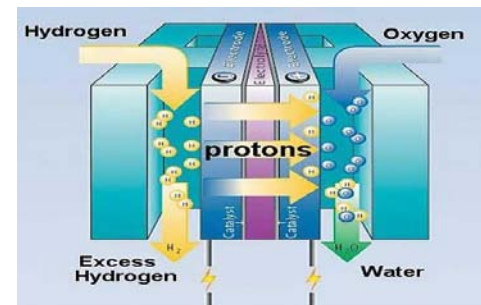
Zumwalt DDG 1000



Maglev Trains

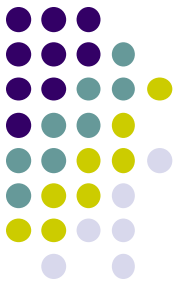


High Energy Density Capacitors



Fuel Cell Systems

# Key Requirements for Sustained Clean Energy Growth



***Supply & Price Predictability.*** RE supply and demand has to be in reasonable balance (in spite of error bars) leading to

- Reasonable price stability
- Reasonable prices

***Political Will*** that matches the societal drivers for renewable energy



# Closing Remarks

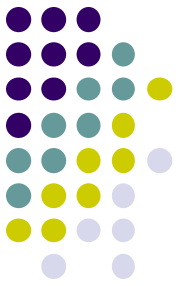
- Clean Energy Demand will drive RE industry growth for the foreseeable future
- Whole supply chains need to be created especially in the EU and US to serve this market.
- Intellectual infrastructures need to be rebuilt as well.
- New economically viable RE resources outside of China need to be commercialized to fill supply gaps starting in 2015



# Closing Remarks

- In the short run it will be very hard to equilibrate Clean Energy demand (with its huge “error bars”) and a 5-12 year and \$1 billion process to bring a new RE resource into production. ***Transparency and open communication are key between all stakeholders from OEMs to owners of RE resources.***
- While we would all like to see a shortening of the 5-12 year historic timeline to commercialize a RE resource, there can be no short-cutting in the process itself. ***Environmental standards should not be compromised***

# Closing Remarks



- Supply / Demand variables to watch:
  - Stock piling by governments and companies
  - Overreaction by magnet purchasers to replace Chinese supply when their supply chain may be secure
  - China's next quota announcements for Q3 and Q4
- The Investment Community will weed out the pretenders from the winners - those RE properties looking for development capital
  - They demand the process rigor to prove and operation is economically viable
  - We need to identify the root causes of the long duration of the process and see if anything can be done to cut significant time out of the system