Challenges Facing New Global Rare Earth Separation Plants

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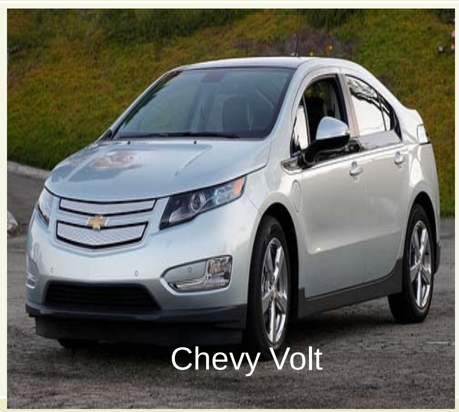
The Promise of Clean Energy Applications for REPM

Applications		Typical Quantity of REO per unit
Traditional – disc drives, personal electronic devices, etc.		Grams
Hybrid and electric vehicles – direct drives and electric assist motors	 Chevy Volt	**Kilograms**
Direct Drive Wind Turbines		**Metric Ton**

Central Issue

Issue: *China has no incentive to support supply chains outside of its borders*

- Internal demand is too great
- Great success to date leveraging its monopoly position in RE to get downstream manufacturing moved to China

Solution: Stakeholders create globally competitive and diverse supply chains for Clean Energy and traditional RE applications

Seems Simple Enough - Why the Crisis?

If these RE markets are so compelling, why aren't there five new RE processing plants - outside of China - already financed and ready to produce RE materials?

Investor Due Diligence

Investors have to understand the risks associated with each individual / unique project

Answers that take time and resources to determine

- Technical Risks
- Commercial Risks
- Sovereign Risks

Rigorous Due Diligence Yields Quantification of Risks

IMCOA's "Road to Commercial Rare Earths Production" is a 10 Step Process that culminates in completion of a "Bankable" feasibility study that is technically and commercially compelling enough to secure project funding for construction and start-up

Historically this is a 5 – 12 year process at a typical cost of ***$500 million to $1 billion***.

The Road to Commercial Rare Earths Production: Step #3

3 Pre-Feasibility Study

- Define ore reserve
- Define process –ore to separated REOs
- Site(s) selection
- Management of radioactive wastes
- Obtain funding for pilot plant, EIS & Bankable Feasibility Study

The Road to Commercial Rare Earths Production: Step #9

9 Complete Bankable Feasibility Study

- Based on
  - Proven *Reserves* (standards often set by the bank)
  - Pilot plant data for all unit ops
  - Environmental approvals
  - Letters of Intent from customers
- Negotiate chemical supply contracts
- Allow adequate start-up time
- Secure Project Funding (Debt and/or Equity?)

The Road to Commercial Rare Earths Production: Step #10

10 Construction and Start-up

- Manage working capital
- Provide training for key production personnel
- Keep to schedule

Technical Risks

- Limited technical know how outside of China
  - Outsourcing options limited
  - Training and development of internal talent needs to be factored in
- Each ore body is different in terms of mineralogy, weathering, and other key chemical and physical characteristics
- All RE deposits have radioactive waste that has to be dealt with
- REE - chemically similar, so difficult to separate

Solvent Extraction Process

- Capital Intensive
- Expensive to Operate
- Extremely sensitive to start-up and shut-down affecting yields significantly
- As much art as science to operate

Commercial Risks

- Chinese domination of industry will continue

- Demand for the entire portfolio of REs is never in *BALANCE* with supply
  - In a typical RE operation, you get at least 3X of Ce and 2X of La for every kg of REPM oxides produced
  - Without new markets for Ce and La these co-product's variable and fixed costs will have to be absorbed by those products that can be sold, ***more than doubling the cost of manufacturing and jeopardizing profitability for the operation***

Commercial Risks

- No independent pricing authority like the LME
- Prices cited in Metal-Pages and the like are of individual transactions that are reported to the publication

- Timing – Who will be the first few non-Chinese properties to market?

Commercial Risks

- Capital intensive
  - Infrastructure for utilities, transportation, chemicals
  - Process equipment

- In the case of a number of new RE properties, commercial success of the RE operation will be tied to the success of extracting and selling other minerals within the deposit - complicating further the risk equations
  - Zircon, U, P, Ni, Ta and Fe

Sovereign Risks

- Deposits are often found in developing countries with little technical or commercial infrastructures or experience in developing mine properties
- Politics and culture issues
- Differ country by country
- Expect the unexpected
- Get help but stay engaged

Closing Remarks

- Clean Energy Demand will drive RE industry growth for the foreseeable future
- New RE properties outside of China need to be commercialized ASAP
- The number of RE properties outside of China that need to be commercialized is yet to be determined

Closing Remarks

- 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.

- Completion of the Bankable Feasibility Study (or the equivalent) by all RE property owners looking for capital will mitigate the risk of global overproduction of RE materials

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