

# **A Study Of Electrolytic Manganese Metal (EMM ) Industry And China's Dominating Effects To The Global Market**

Version 1.08

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## Executive Summary

Establishing Electrolytic Manganese Metals (EMM) production outside China by leveraging the low grade manganese and advanced technologies presents a viable business model and promising investment opportunity because, in addition to the strong and growing demand driven by the stainless and specialty steels from China and India, the EMM production cost in China is rapidly rising due to the **depleting resources, increasing electricity and labor cost, and additional investment to comply with environmental regulations.**

## Absolute Supply Dominance of EMM Production by China

### Made In China

*“After more than 30 years high growth, China has made itself the world manufacturing center”*

A by-product of its unprecedented efforts to reform the country from a central-planning old Soviet Union model to a market-driven economy, China has become the undisputed world factory after more than 30 years high growth. The outcome of the low-cost production has changed many industries across the world, from the consumer side of equation (i.e. electronics, clothing, toys, Christmas trees, appliances, furniture, etc.) to industrial materials, such as Rare Earth metals and electrolytic manganese metals (EMM). In 2010, China alone accounts for 98% of the global EMM production.

The abundant labor from the rural areas, and their willingness to accept low wages, as well as the beneficial policies in land uses, preferred taxes, and minimum regulations offered by central and local governments to attract investments played key roles in making China the world manufacturing center. As a result the western world has lost, willingly or unwillingly, many of its production capabilities in variety of industries.

Rare Earth Elements (REE) and Electrolytic Manganese Metals (EMM) are two perfect examples in mining industry. There was no meaningful REE production outside China when China started to reform its industry in 2008. The consequence to the critical metal sector has clearly been demonstrated within and outside China.

A similar case can be seen for EMM, as the western world remains as unprepared for production disruptions as it was for REE crisis. It is very conceivable that a repeated REE crisis scenario could take place for EMM as China economy continues to evolve simply because REE and EMM share the fundamental attributes at the center of the issue, which are:

- They are both critical metals;
- Both productions are dominated and highly demanded within China, and

- Both are needed by outside world which depends on low-cost supplies from China.

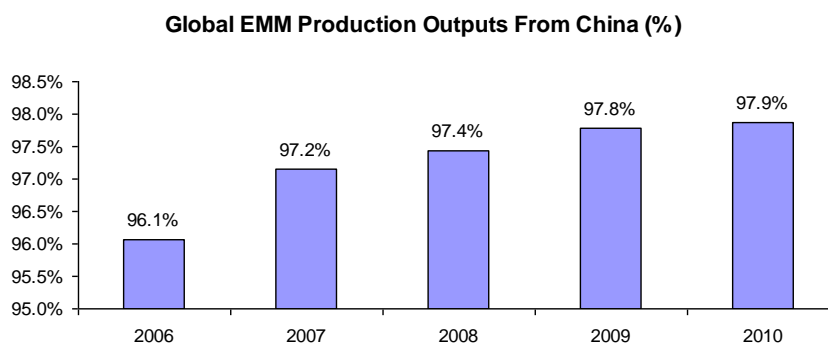
Although many people refuse to recognize the fact that the cheap “Made-in-China” products era is over, from China’s perspective there are no incentives at this stage of economic development to continue to export low margin raw materials, like REE and EMM, at the cost of its natural resources, high energy consumption, and rising environmental pollution.

### Electrolytic Manganese Metals (EMM) - The Only Game In Town

*“China dominates 98% of global EMM production, it is the only game in town”*

China dominates the electrolytic manganese metal market in terms of both production and consumption. As of 2010, China has developed 2.2 million tonnes EMM production capacity in its 12 provinces across the country. The majority of the capacity is concentrated in the Manganese Delta region, namely Hunan, Guanxi, and Guizhou province, which accounts for 68 percent (1.49 million tonnes) of the total national production capacity. Nationally, 188 enterprises produced 1.38 million tonnes of EMM in 2010 accounting 98% of the global EMM production outputs. 103 thousand tonnes were exported and remaining 1.28 million tonnes were consumed domestically. It could take years to unwind this monopoly.

Exhibit 1: Global EMM Production Output From China (by percentage)



## China EMM Market Is To be Consolidated

*“China is consolidating the EMM industry to eliminate small and medium producers to better use resources and protect environments”*

At present, EMM production in China is very fragmented. In 2010, there were 188 enterprises that produced a total of 1.38 million tonnes EMM. The average EMM production output per producer was less than 7,000 TPY (Tonne Per Year). This is because small and medium EMM plants are the fast way for local governments to create jobs and generate revenue.

To achieve GDP and employment target mandated by central government, the local governments very often compromise the industry entry standards and environmental regulations. Small plants are allowed to operate without proper safety and environment protection equipment and infrastructure. The resulting pollution to the local water system by EMM producers creates tremendous tension between the EMM producers and local residents and has raised great concern with the central government. The recent water pollution event at the “Sichuan Minjiang EMM Factory” in Sichuan province (a 24,000 TPY and ISO 9001 accredited EMM producer) was broadly reported by media in China. It is a key indicator of the seriousness and depth of the issue.

In 2010, Ministry of Industry and Information Technology (MIIT) commissioned the Chinese Manganese Industry Technical Commission to formulate a roadmap to eliminate EMM plants that have production lines below 5,000 TPY and plants that do not comply with environmental requirements. Through this initiative in 2011 and 2012, between 500,000 to 700,000 tonnes EMM production capacity will be eliminated from the current total available production capacity of 2.2 million tonnes. As a result, the overall EMM production capacity remaining in China would be between 1.3 to 1.5 million tonnes.

Emulating the strategy used in previous REE consolidation, state-owned large enterprises (SOEs), such as China Minmetals and Citic Group, will take the leading role in the consolidation process over the next 5 to 10 to completely reshape China EMM market landscape. It is likely that 10 to 15 major EMM producers will be remained and survived at the end of the process, controlling 90% of the production capacity and outputs. The surviving of EMM producers provide better vehicle of control and

compliance for resolving environmental and social issues, while gaining the scale and size that required to compete globally.

### **Striking A Fine Supply Balance**

*“China needs to balance EMM production capacity to ensure the adequate supplies to the domestic market while avoiding price undercutting, preserving resource, and protecting the environment”*

China has the upper hand to define EMM industry given its current unchallengeable dominant production position. The question for the policy makers in China, however, is how to build a sustainable industry that meets the market needs, and that also is environment friendly and energy efficient.

Currently the biggest issue for EMM industry in China is not overcapacity but under regulation. The government has to find the right balance by raising the industry entry criteria and enforcing regulations to protect the environment and preserve the depleting resources, while sustaining economic development. The compromising of market entrance standards is the main cause of the short-term overcapacity and price-undercutting that undermines the market price discovery mechanism.

In its 12<sup>th</sup> five-year plan, the government has given a high priority to either eliminating or relocating high-energy consumption and environment unfriendly industries. The initiative by MIIT to eliminate 500,000 to 700,000 tonnes EMM capacity by 2012 is the first step to move towards that goal. The overall objective of the initiative is to encourage the industrial consolidation led by SOEs to create a few conglomerates that can dominate the market shares and lead the innovation to improve environment quality and promote energy efficiency.

### **China Will Continue To Lead Steel Industry Growth**

*“China needs to build infrastructure to accommodate 395 million migrant workers in urban areas by 2020*

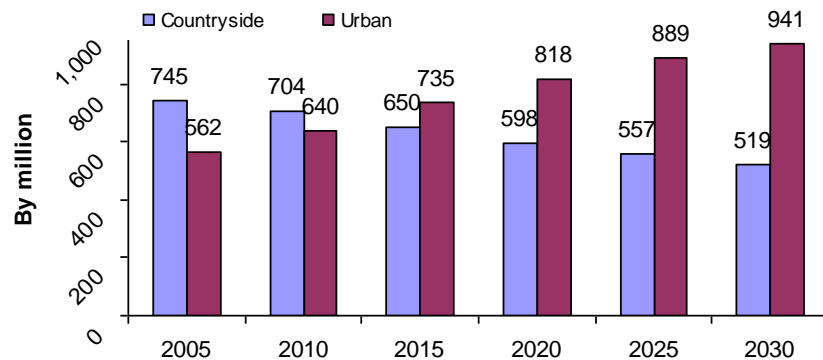
China needs to maintain minimum 4% GDP growth to achieve the national target of doubling its 2000 GDP by 2020. Many economists believe China needs to maintain 6-8% GDP growth to ensure the social stability and adequate employment of the migrant workers.

Traditionally 70% of the population in China lives in countryside and rural areas. Only with a few exceptions, changing primary residence is extremely restricted. During last 3 decades, vast numbers of migrant

workers and their families have been allowed to leave their homes and re-locate to more developed and urban areas to find jobs, without changing their permanent residences. This started the largest urbanization process in human’s history. At the end of 2008, approximately 225 million<sup>1</sup> migrant workers temporarily work and live outside their permanent residences. According to the National Population and Family Planning Commission, an additional 170 million migrant workers will be relocated to urban areas by 2020. This human migration phenomenon is the core engine of China’s growth in next 2 to 3 decades.

The current infrastructure is not sufficient to support the 395 million migrant workers. To address this issue, the existing infrastructure must be improved and new housing, highways, schools, hospitals etc must be built. In next 3 to 4 years, 36 million economic housing units must be built in accordance with the state council to cool down the over-heated housing market. There is no question if China needs more steels, the question is how much more?

Exhibit 2: China Urbanization Trend By Year 2030



### The World Will Not Stop – Increasing EMM Demand

Manganese demand, including EMM, is primarily driven by the steel industry, which is one the most basic engineering metals with versatile applications throughout the economic value chain. Therefore the demand

<sup>1</sup> Data source: National Statistic Bureau census statistic 2008

in manganese in general will remain on the higher end as the developing countries, like China and India, are going through the industrialization phase of the economy cycle. The growth rate in China might be slowing down, but the overall steel demand is in a consistent rising trend. The consensus forecast for the apparent crude steel consumption by China will be reaching to around 800 million<sup>2</sup> tonnes by 2015, 33% increase compared to 2010.

### **Manganese Demand Are Highly Correlated To The Steel Industry**

*“China needs steels. There is no satisfactory substitute to manganese to make steels. EMM is in high demand driven by the rapid growing stainless steel production”*

The conservative projection of EMM demand for non-200 series stainless steels will reach to 934 thousand tonnes by 2015. In China, the biggest EMM demand is driven by the growing specialty stainless steels segment, specifically by the 200 series stainless steel segment. This results from:

- The replacement of nickel in the production of higher quality stainless steels. Nickel is a key raw material for stainless production. However, nickel resources have been insufficient to satisfy the demand.
- In recent years, 200 series stainless steel substituting for higher grade stainless steels has expanded rapidly because it is cheaper and practical in less severe operating environments.

200 series stainless steel production is 5 million tonnes in 2010, accounting less than 1% of the total steel output. The 200 series stainless steel output is projected at 14.7 million tonnes<sup>3</sup> by 2015, increasing to approximately 1.8% of the total steel production. The EMM used in 200 series stainless steel is projected to reach 1.69 million tonnes, an increase of 194% from current 574 thousand tonnes, over the same period.

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<sup>2</sup> Data source: China Iron & Steel Association

<sup>3</sup> Data source: ZhongAn Consulting

## Rising EMM Production Cost

### The End of Low Cost Made-in-China Products

*“The era of low cost products made in China is over”*

China became the world manufacturing center over the past 3 decades through:

- Economic reform to transform its planned economy into market economy.
- The abundant low-cost labors freed from countryside
- Multinational corporations from developed countries relocating labor-intensive and low-tech productions to low cost regions and countries.
- China’s weak environmental protection regulating framework.

Large trade surplus issues with major developed countries, combined with increasing social pressure to protect the environment and preserve natural resources, have forced China to modify or terminate the favorable economic development policies and to adopt a new production approach which focuses on internal consumption rather than exports. The labor cost, which were the primary competitive factor to attract investments and joint-ventures in 80s and 90s, have also started to increase. Government has implemented the minimum wages in most of the country. Furthermore since 2005 the Chinese currency (RMB) appreciation relative to most foreign currencies has accelerated the rising labor cost in US dollar terms, and there is no indication the currency appreciation has topped. In conclusion, the low-cost manufacturing era in China is over.

### EMM Production Cost Rising In China Is Just Beginning

#### Factor 1: Increasing Manganese Ore Price

With the rapid steel growth in China, manganese ore price has increased drastically starting in 2005 and peaking in 2008. Since 2009, manganese ore price has recovered some of loss following the global recovery and the continuing growth in China. Although the price fluctuated in recent years, the overall manganese ore price has increased close to five times since 2005. As China is manganese ore net importer, and consumed more

*“EMM production costs are on the rise, and could get much higher before stabilizing due to the increased cost of materials, electricity, labor, and environment compliance”*

than 50% of the global production, the manganese ore price globally will remain on the rising track for the foreseeable future.

#### Factor 2: Increasing Electricity Price

Utility is a highly regulated industry in China and the electricity price is not completely determined by the market. Any increase of electricity price must be approved by NDRC<sup>4</sup> and consequences of violation are harsh.

With its rapid growth, unbalanced industrial structure, and lack of coal and other alternative power generation, electricity has been in severely short supply in China in past few years. Both residential and industrial consumers are interrupted frequently by the cascading blackouts, with the situation getting worse in 2010 and 2011.

To cover the mounting loss by the 5 big generators, NDRC has allowed small increases in industrial electricity in May of 2011, but it barely makes a dent in the issue. NDRC is actively pushing its agenda to deregulate the electricity industry so that the regulated low electricity price regime eventually will be collapsed and replaced by free market mechanism. As a result, the additional cost will be passed onto the end-consumers.

The run-up risk in electricity adds greater pressure and uncertainty to Chinese EMM producers as currently 38% of the production cost of EMM is attributed to electricity.

#### Factor 3: Rising Labor Cost

Labor cost in China is only a fraction of that in developed countries. The direction of labor cost for anything made in China is going up. The mandate to close the income gap has become a national priority in its 12<sup>th</sup> five-year plan. A rapidly aging society, combined with the low birth rate resulted from the “family plan” allowing one child per family, portends a potential loss of work force capacity. The low-wage era is long gone and labor cost in China is expected to rise exponentially.

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<sup>4</sup> National Development And Research Commission

#### Factor 4: Pay For Pollution

China has paid significant price in its environment over the past 30 years to become the world manufacturing center. The abusive exploitation of natural resources and careless production has resulted in extremely significant long term damage to water quality of rivers, farm lands and air quality. Illegal mining, operating without full safety compliance killed hundreds of people, has triggered the nationwide clamp-down on such illegal activities from 2008. Faced with the increasing pressure to stop illegal activities, high-energy consumption, and environmental degradation, individual mining operations will have to either invest to upgrade current equipment and technologies to comply with new social and environmental regulations or face closure. The associated cost will ultimately be passed on to end-consumers.

#### **RMB's Appreciation Expedites The End Of Low Cost Chinese Production**

RMB has appreciated about 23% since 2005 when China government started taking steps to allow RMB to flow more freely. The exchange rate increased from \$US 1:8.22 Rmb to \$US 1:6.36 Rmb in July of 2011. The general consensus is the RMB will continue to appreciate against the US dollar, that will drive the price of all exports even higher.

#### **Depleting Resources**

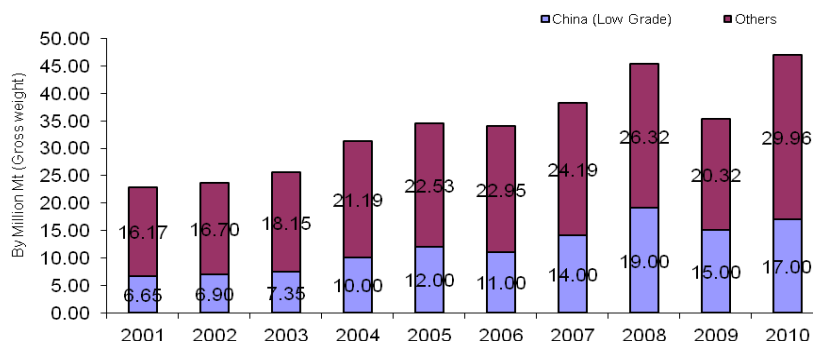
*“High grade manganese ore in China is running out”*

China is a country short of high grade manganese deposits. Most of China's manganese ores are low grade ores with an average manganese grade of 21.4%. Of which, only 6.4% are considered rich manganese ores: That is manganese content greater than 30% in manganese oxide ores, or greater than 25% in manganese carbonate ores. the remaining 93.6% are considered lean manganese ores.

As indicated in Exhibit 3, China has not reported any manganese production ores with grade higher than 30% since 2001. The average grade ores that are being mined in China is estimated at grade 18% in 2010, which is 14% lower than the world average grade during the same year. Manganese ore grades have been gradually declining over the past 9

years. It is very likely the existing mid-grade<sup>5</sup> and high-grade<sup>6</sup> ores have been depleted.

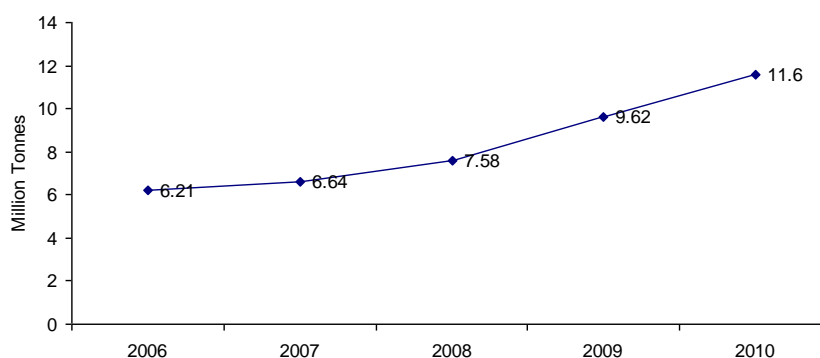
Exhibit 3: World Manganese Ore Production<sup>7</sup> (2001 to 2010)



On the other hand manganese ore apparent consumption is increasing year over year in China, Consumption has reached 7.5 million<sup>8</sup> tonnes (metal weight) in 2010 while only 3.06 million tonnes (metal weight) were produced in China that year. To meet the increasing manganese ore demand, China depends on imports mainly from Africa and Australia (as illustrated in Exhibit 4).

*“China EMM industry increasingly depends on imported manganese ore to keep the current production level”*

Exhibit 4: China Imported Manganese<sup>9</sup> (2006 - 2010 by million Mt)



According to US Minerals Survey in 1999, the total manganese reserves in the world are 660 million tonnes (metal weight). China ranked at third place with 40 million tonnes (metal weight) total reserves. A survey conducted by China Manganese Industry Technical Commission in early

<sup>5</sup> Manganese ore with grade greater than (or equal to) 30% but less than 44% defined by IMnI

<sup>6</sup> Manganese ore with grade greater than (or equal to) 44% defined by IMnI

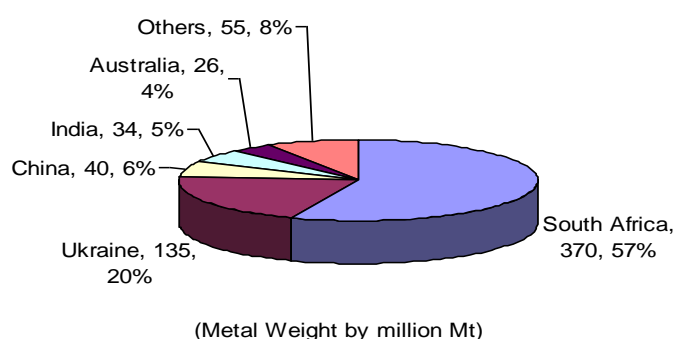
<sup>7</sup> Data Source: IMnI

<sup>8</sup> Data Source: IMnI

<sup>9</sup> Data Source: IMnI

2000 indicates 186 million tonnes manganese ores basic reserves at average 21% grade. It is in principle in line with data from the US Mineral Surveys after being converted to metal weights. However, manganese reserves in China mainly are lower grade, scattered in many small deposits that have little or no economic value for mining. These two sets of data point to a similar conclusion: China is running out of economic grade manganese ores.

Exhibit 5: World Manganese Reserves (1999)<sup>10</sup>



*“China’s current EMM production sites are concentrated in a area where infrastructure are under-developed”*

In China manganese ores have been identified in 21 provinces, cities and autonomous regions, with most of the resources being located in the south. Guangxi and Hunan province account for 56% of national manganese ore reserves. Together with Guizhou, they are called Manganese Delta Region. Local infrastructure is under-developed, and transportation is typically interrupted by severe weather.

<sup>10</sup> Data source: US Mineral Survey (1999)

Exhibit 6: China Manganese Delta Region



## Market Opportunities

### A Rapid Growing EMM Market

*“Growing demand and uncertainty of supply from China present a compelling business case to re-establish EMM production outside China”*

The strong and growing demand of EMM by emerging economies, combined with the declining supply from China, provide a new opportunity window for the existing producers and potential new entrants. The 2010 worldwide EMM revenue is approximately US\$ 5.0 billion and is projected to reach between US\$ 14.3 to 15.9 billion<sup>11</sup> by 2015. The majority of the growth will come from China and India. Establishing EMM production capability outside of China presents solid investment opportunity because China is expected to become a potential EMM net importer within the next 5 to 10 years.

It is clearly stated in its 12<sup>th</sup> five-year plan that China is determined to eventually eliminate high-energy consumption and polluting industries by either closing the offending operations or replacing them with cleaner and energy-efficient production environment. The EMM industry in China will be facing extremely tough regulations to comply with the 12<sup>th</sup> five-year mandates and environment laws unless breakthrough technologies are emerged that can significantly reduce the cost, power consumption, and manganese resource. Rising production cost and depleting manganese

<sup>11</sup>Projection of 2.6 to 2.9 million tonnes global demand at US\$ 5,500.00 per tonne

ores also combine to curtail Chinese supply, China will still maintains its dominant supply position in the near term as the industry is being consolidated, but overall EMM supply from China will very likely start declining during the process.

### **The Necessity Of EMM Re-production In Western Countries**

Over the past 30 years, western countries have lost not only millions jobs by outsourcing operations to low-cost labor countries, but also supply chain independence and reliability for many critical resources. Supply chain security, in general, takes much longer time to re-establish.

*“The world needs to wake up to face the changing reality in critical metal space with a new game plan”*

The emerging economic power of BRIC (Brazil, Russia, India, and China) and the continuing US housing and European sovereign debts crisis are causing the economic globalization to enter a new phase. This is characterized by exploding population growth, strong demand but severe shortage of commodities, and geopolitical issues intertwined with economic activities.

Facing the new reality, industry leaders and policy makers must re-examine their critical resource operating strategy to re-establish local production capabilities. For example, re-opening of the Mountain Pass rare earth elements project in California by Denver-based Molycorp is a small first step taken by American mining industry and investment community to re-establish REE production in North America and therefore remove the dependence to imported REEs.

EMM has its unique economic value to today’s global economy due to its irreplaceable role in making stainless and specialty steels. The production currently concentrated in China poses a great supply risk to external customers given that Chinese production costs are rising and the potential supply shortage as China concentrates on meeting its growing domestic demand.

EMM is not exchange-traded, and this lack of a liquid hedging tool makes it difficult mitigate the pricing fluctuations and other risks to producers and customers.

### **Key Challenges To New Entrants**

The first challenge faced by the new entrant is the availability of a large manganese resource. A significant high grade manganese resource has not discovered in North America, but large near surface low grade manganese deposits have been identified. In order to establish a viable and profitable production from such low grade deposits, a new entrant needs to take advantage of the sound infrastructure in North America and leverage new technologies to reduce the capital and production costs.

A potential EMM new entrants also needs to manage the currency risk. The EMM price quoted internationally in US dollars, while the dominant Chinese producers quote their production costs in the local currency: Chinese Rmb, The Rmb, under the current capital account, is not freely convertible and is under pressure from western countries to appreciate. The Chinese EMM production cost will be volatile if the Rmb fluctuates widely, causing great uncertainty for both producers and end-customers.  
*(End)*