CPM Group

Manganese Market Outlook

February 2012

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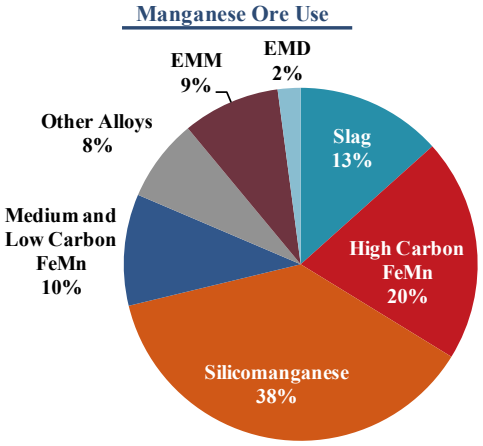
(This Section has been excerpted from CPM Group's Manganese Market Outlook, 2012)

EXECUTIVE SUMMARY

Manganese is an essential industrial metal used as an additive in a wide range of steels, non-ferrous alloys, and electronic components, as well as in specialty chemical applications. In the steel manufacturing process, the addition of manganese removes impurities such as sulfur and oxygen. It also optimizes the physical properties of the steel by improving its strength, hardness, and abrasion resistance.



Source: CPM Group, IMnl, company documents

Of the roughly 15 million mt of manganese produced (metal content), roughly 89% is upgraded into alloyed manganese and foundry products. High, medium, and low carbon ferromanganese along with silicomanganese fall into this category. The remaining 11% of manganese ore is consumed in the production of metallurgical and chemical products, including electrolytic manganese metal (EMM), electrolytic manganese dioxide (EMD), lithium manganese oxide, manganese sulfate, and other chemicals. The primary focus of this report is on electrolytic manganese metal, which is produced through the electrolysis of a sulphate solution and sold as flakes or as powder. While the EMM market is dominated by Chinese producers and consumers, structural shifts in supply fundamentals have transformed the metal's relative value. In addition to increased regulatory pressures in China, falling Chinese ore grades, and rising production costs are opening up new opportunities for producers outside China.

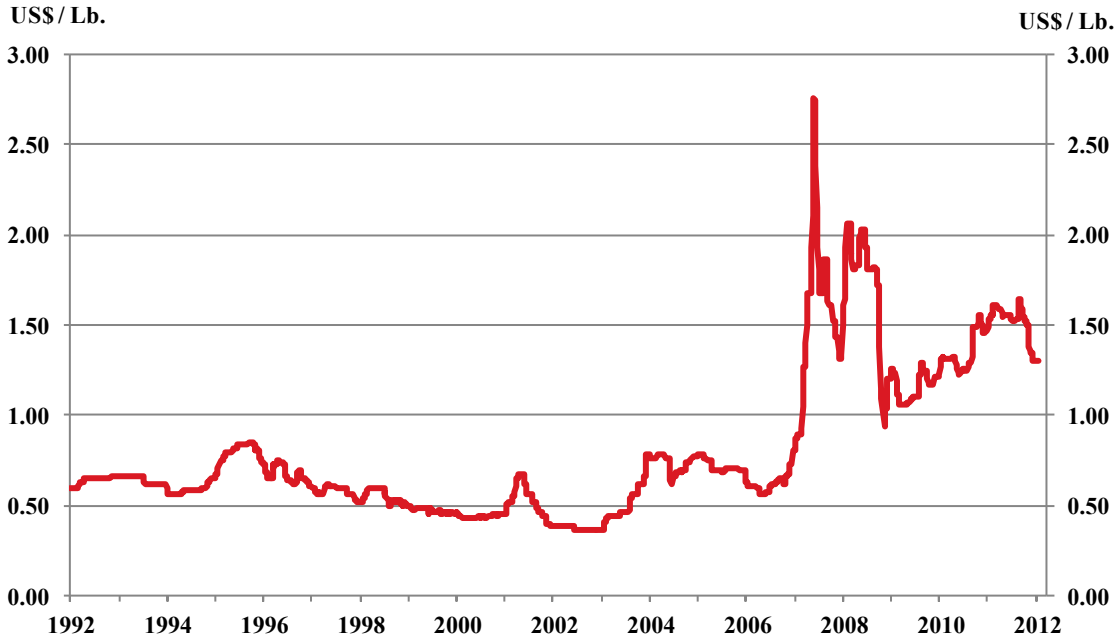
The EMM market is highly concentrated with over 97% of global EMM production sourced from China in 2010. South Africa, the only other EMM producing country, accounted for the remaining 2.1% of global supply. Rapid growth in Chinese EMM capacity tied to robust demand fundamentals and lenient government regulation has crowded out producers in the United States and Japan over the past two decades. Over the past five years EMM prices have become more reflective of the tightening regulations governing the Chinese EMM industry. At the same time, with improved steel technology in China, EMM has grown to be increasingly attractive as a substitute for higher cost alloys in steel. While the environment for both EMM supply and demand continues to evolve, the metal has established new structural price supports, partially based on cost inflation throughout the industry. Between 2012 and 2021 real EMM prices are forecast to average $1.92 per pound, which will support project development activities and provide incentive pricing for bringing new projects online to meet continued growth in demand. In 2021 alone annual EMM demand may grow by more than 140,000 mt, which is equivalent to the annual output from roughly four medium-scale operations in China.

Historical and Recent Price Trends

In tandem with the industrialization of China, structural changes in the EMM market started to emerge in the early part of the last decade. In the 2000s, nominal monthly EMM prices rose more than six-fold from US$0.36 per pound in the second half of 2002 to $2.41 in June 2007. While a supply shock and speculation about Chinese regulation helped bolster prices to these highs, prices then remained at elevated levels, averaging roughly $1.76 until the global economic downturn in the fourth quarter of 2008. Market conditions for the industrial metal quickly shifted course in late September 2008 as the world economic environment turned decidedly negative. However, EMM prices were rather robust, holding

Electrolytic Manganese Flake Prices (min 99.7% Mn)

Bi -Weekly, Through January 2012



Source: Metal Bulletin

largely above $1.00. Prices have been leveraged to the high growth Chinese market, with the country accounting for nearly 87% of global EMM demand. After temporarily falling to a monthly low of $0.99 in November 2008, prices rose in a choppy fashion over the following three years, buffeted by cyclical destocking and restocking activities in the steel industry. In 2011 manganese flake prices averaged $1.53. Concerns over the European debt crises and slower growth in China weighed on commodity prices, in general, in the fourth quarter of 2011. Going forward, many of the underlying fundamentals, which contributed to elevated EMM prices, namely rising production costs, more stringent Chinese regulations, and strong demand growth, remain intact.

Supply

While manganese is the 12th most abundant element in the earth's crust, reserves are irregularly distributed. Data from the United States Geological Survey (USGS, 2008) showed that South Africa (77%) held the greatest share of the 5.2 billion mt in the global *reserve base*, followed by Ukraine with roughly 10%. Manganese ore reserves in South Africa are for the most part high manganese grades (greater than 44% Mn) and in the Ukraine ore grades are typically lower (less than 30% Mn). Global *reserves* are more regionally diverse. Nearly three-quarters of the world's manganese reserves are in the Ukraine (22.2%), South Africa (19.0%), Brazil (17.5%), and India (14.8%), according to 2010 USGS estimates. Ore reserves in China account for roughly 7.0% of global reserves. However, Chinese manganese ore grades are low and production grades have been falling by 0.5% to 1.0% per year. China is becoming increasing dependent on overseas ore supplies. In 2010 imported manganese in ore accounted for roughly 55% of China's total manganese demand. Secondary supplies or scrap is not currently a commercially viable, material source of manganese.

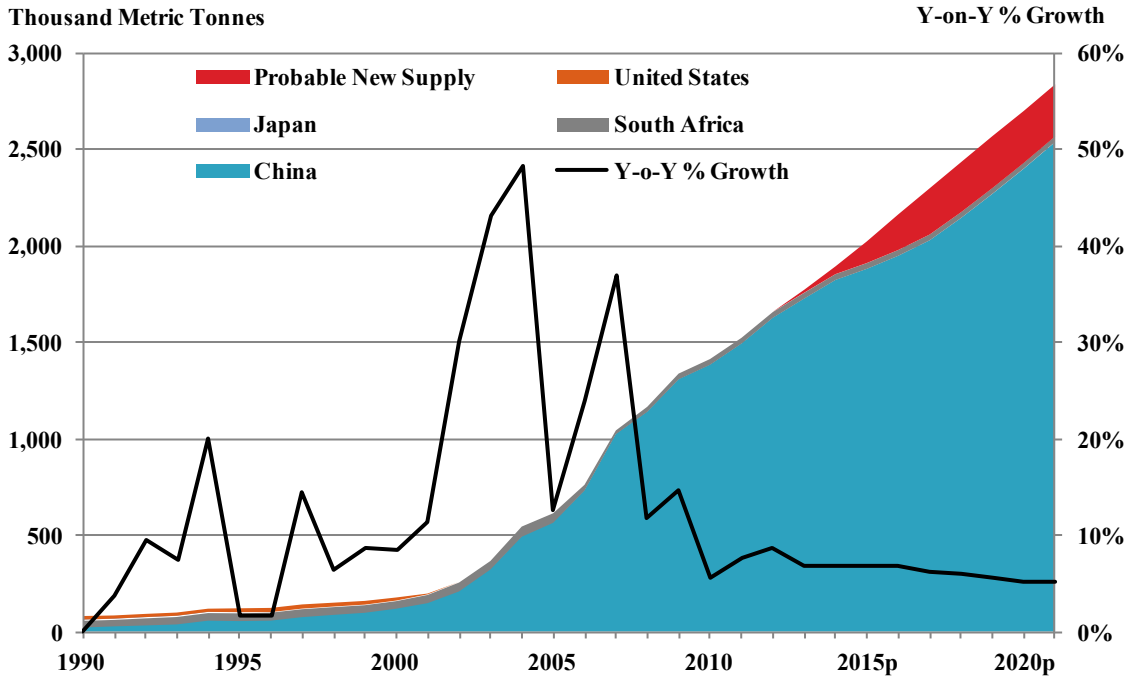
Manganese occurs in a variety of mineral compositions, including in the form of manganese oxides and hydroxides, manganese-bearing carbonates, and silicates. However, all types of manganese ore require

processing to transform the feedstock into useable products. Both silicomanganese and EMM are primarily produced from low grade ore. However, falling ore grades and increased political pressure to reduce the environmental impact of the manganese industry have made EMM production from high grade ore more attractive, despite higher capital expenditures. In 2010 EMM total cash costs for Chinese producers exporting EMM fabricated from domestic low grade carbonate ore (10% Mn) were roughly $1.32, nearly 13% more expensive than producing from imported high grade ore (45% Mn). Currently the vast majority of Chinese EMM output is produced with domestic ore, while imported ore is use for alloy manganese products. The Chinese government has taken concerted actions to limit exports of materials with energy intensive, polluting production processes. When selling to overseas markets, Chinese producers must pay a 17% Value Added Tax (VAT) on most input costs and a 20% export tax.

Despite pressure from the central government for consolidation in the industry, the manganese mining sector remains highly fragmented with roughly 600 manganese mining companies. The EMM market is slightly more concentrated, with less than 200 EMM producers. To meet long term strategic plans, the government will continue to promote industry concentration by eliminating small EMM producers with outdated technologies. Chinese industry participants expect that regulators will target small EMM producers with a single production line of less than 5,000 mt in annual capacity during the current Five Year Plan.

Falling ore grades, increasing operating costs, and low recoveries are weighing on Chinese production. China is estimated to have produced 1.38 millon mt of EMM in 2010. Between 2011 and 2021 Chinese production is forecast to grow at a CAGR of 5.4%, compared to a CAGR of 30.0% during the previous decade. The tightening of environmental standards and industry restructuring initiatives are expected to reduce surplus capacities in the long run. Capacity utilization stood at roughly 63% in 2010.

Electrolytic Manganese Metal Production by Country



Source: CPM Group, Company Reports, Industry Sources

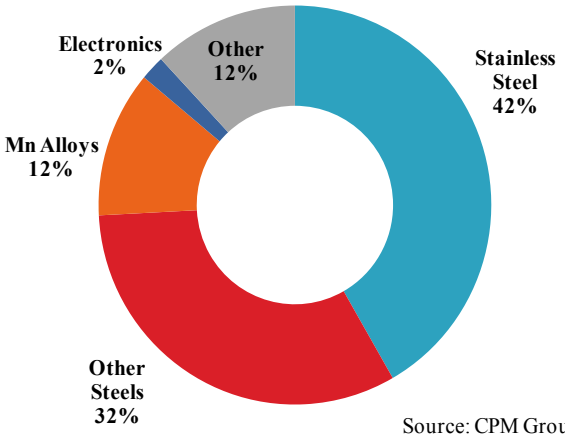
South African producer, Manganese Metal Company, also has 30,000 mt of EMM production capacity. Despite South Africa's mineral wealth, increased demand for non-Chinese, dependable EMM supplies is not expected to be met by new EMM capacity in South Africa due to the country's inadequate electrical grid.

EMM Demand

Manganese is the desired alloying element for applications in which cost-savings and moderate corrosion resistance is preferred. Thus, EMM is employed in a wide range of applications, including 200-series stainless steels used for mostly consumer applications, other steels, non-ferrous alloys in the canning industry, electronic components, and specialty chemical applications.

The widespread use of EMM in steel-related applications is reflected in the breakdown of EMM demand. Nearly 74% of EMM demand is derived from the steel sector. Specialty alloys such as aluminum alloys account for 12% of global demand, while other end-uses, including electronics and chemicals, account for the remaining 14%.

Global EMM End-Uses, 2011e



Source: CPM Group

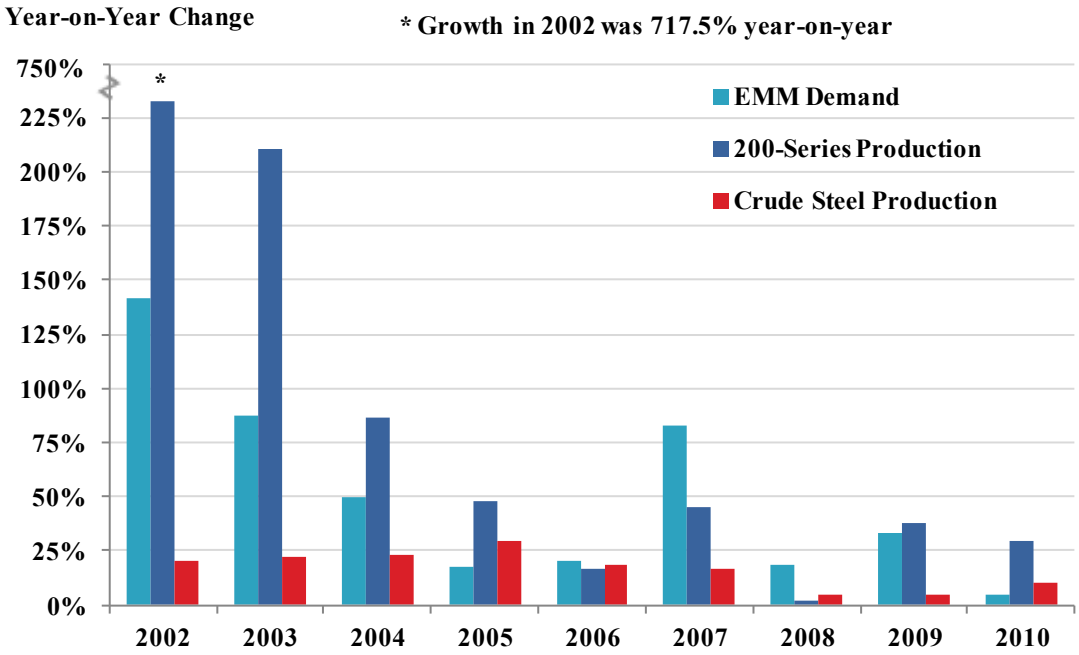
EMM demand is largely driven by fluctuations in Chinese steel production. China accounts for over 87% of global EMM demand, with the steel sector accounting for nearly 82% of domestic consumption. Urbanization in many emerging economies and growth in Chinese industrial production over the past decade have resulted in strong EMM demand growth rates, despite the 2008 - 2009 downturn in global economic activity. Improvements in economic sentiment over the course of 2010, following the economic recession, encouraged increased capital expenditures, fixed asset investments, and personal expenditures over this period.

EMM Consumption and the Steel Sector

EMM is mainly used as an alloying element in the steel sector. Steel would not be able to achieve the necessary tensile strength, toughness, stiffness, wear resistance and hardness in the absence of manganese additions. EMM specifically is used in place of other manganese products, such as ferromanganese, as an alloy when the desired end-product requires very low levels of impurities. In ferromanganese, for instance, higher impurity levels such phosphorous degrades the weldability of steel. In other cases, EMM is preferred due to the specific requirements of certain steel production processes.

EMM demand from the steel industry accounts for nearly 74% of total demand. EMM can be found in stainless, carbon, construction, engineering, non-magnetic, Hadfield, and HSLA steels. Steel-based EMM demand has exhibited stronger growth rates than global crude steel production over the past decade due to improvements in the quality of 200-series stainless steel, the EMM market's leverage to the Chinese market in terms of both production and consumption, and nickel substitution. CPM Group expects EMM demand from the steel sector to increase at a compound annual growth rate (CAGR) of 6.7% from 2011 to 2021, rising from 1.1 million mt in 2011 to 2.2 million mt in 2021.

China: EMM Demand, Crude Steel Production and 200-Series Steel Production Growth
Annual, 2002 - 2010



Source: CPM Group, ISSF, World Steel, Antaike

Stainless Steel

The largest end-use of EMM is in stainless steel, accounting for nearly 42% of global demand. In low to moderate-corrosion applications such as home appliances, kitchenware, and ornamental fittings, 200-series grades have been increasingly consumed due to the cost advantages over pricier, high nickel-content steels. EMM also is employed in high-performance stainless steels that require minimal carbon contents. The increase in the 200-series' market share of stainless steel production also reflects improved production processes.

Other Steel

Other steel types collectively account for 32% of global EMM demand. Other steel grades in this category include construction steels, engineering steels, non-magnetic steels, Hadfield steels, and HSLA steels. These steel grades are used in the automotive, construction, energy, infrastructure, and transportation industries.

Other EMM Applications

Aluminum and Other Alloys

Aluminum and other alloys are the third largest consumer of EMM by end-use, accounting for nearly 12% of global demand. Manganese is found in aluminum, magnesium, copper, nickel, titanium, and zinc alloys. Of these, aluminum alloys are the largest consumer of EMM in the form of briquettes, which can contain anywhere from 75% - 90% manganese. The addition of manganese to aluminum alloys is a low-cost method of increasing hardenability, corrosion resistance, deoxidization, and castability properties, as well as imparting mechanical strength to the aluminum alloy. These alloys are used extensively in aluminum cans. EMM demand from this end-use is expected to increase from 181,355 mt in 2011 to 322,373 mt in 2021, a 5.9% CAGR.

Electronics

Electronics account for almost 2% of EMM consumption by end-use. EMM is commonly used as a raw material for soft ferrite powder production. Soft ferrites are used in computers, communications equipment, automobiles, televisions, and vending machines for their electromagnetic properties. EMM consumption in this end-use is expected to continue to reflect global production trends in electronic equipment, growing from 30,676 mt in 2011 to 50,376 mt in 2021, a 5.1% CAGR.

Other

Other end-uses collectively account for 12% of global EMM demand. Of these end-uses, batteries are the largest consumer of EMM. EMM is sometimes used in dry-cell zinc-carbon, alkaline, and lithium-based batteries, though EMD is commonly prevalent in the latter two instances. Other end-uses include dyes, disinfectants, catalysts for chlorination reactions, various agricultural uses, anti-bacterial and anti-fungicidal agents, and in welding rod electrodes. Other end-uses are expected to grow at a CAGR of 5.0%, from 183,614 mt in 2011 to 299,050 mt in 2021.

Electrolytic Manganese Metal End-Uses and Properties

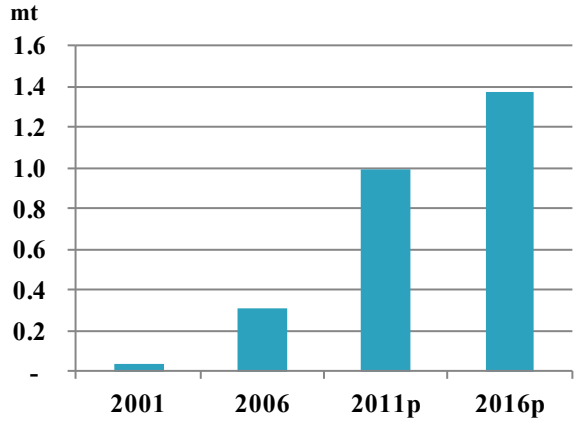
End-Use	Properties	Effect
Steel	- Strong sulphide former - Deoxidant - Weak carbide former - Alloying element	-Reduces undesirable amount of sulphur and oxygen in steel - Improves the response of steel to quenching - Enhances mechanical properties of steel by increasing hardenability rate
Non-ferrous Alloys	- Deoxidant - Alloying element	- Enhances corrosion resistance of Al alloys - Improves copper alloys castability and strength - Can replace part of the Nickel in Ni-Al alloys
Other	- Depolarizer - Bacteridal - Fungicidal	- Used in dry-cell batteries in the manganese dioxide form - Used in purifying drinking water, treating waste water, and odour control - Used for controlling crop and cereal diseases

Source: CPM Group, company documents

Focus on Chinese EMM Demand

OECD economies play a marginal role in the EMM market given that China overwhelmingly dominates consumption. Thus, it is necessary to emphasize both the importance of China in the EMM market and the growth in consumption that has occurred over the past decade. On a per-ton basis, Chinese EMM consumption is nearly ten times higher than it was at the start of last decade. EMM demand per-capita is expected to continue to grow as urbanization lends support to demand for consumer products, many of which employ EMM-containing 200-series stainless steel. Chinese manufacturing activity is expected to be buoyed by healthy fixed asset investment levels.

Chinese Consumption of EMM per 1,000 People
Annual, Select Years



Source: CPM Group, IMF

CPM Group Electrolytic Manganese Metal Projections
Compounded Annual Growth Rates

	2005 - 2011e	2011e - 2016p	2016p - 2021p	2011e - 2021p
Steel	**22.8%**	**7.2%**	**6.1%**	**6.7%**
Mn Alloys	**-5.5%**	**6.7%**	**5.2%**	**5.9%**
Electronics	**6.6%**	**5.9%**	**4.2%**	**5.1%**
Other	**30.2%**	**6.1%**	**3.9%**	**5.0%**
Total	**15.5%**	**7.0%**	**5.7%**	**6.4%**
China	**45.5%**	**7.2%**	**5.9%**	**6.6%**
Rest of World	**-7.6%**	**5.5%**	**4.2%**	**4.9%**
Global	**9.4%**	**7.0%**	**5.7%**	**6.4%**

Source: CPM Group

Substitutes

CPM Group's analysis of historical market developments, technical considerations, and relative economics has concluded that manganese is used mostly as a cost-saving alloy, and the scope for EMM substitution is moderate. Three main substitution threats may result in lower volumes of EMM over the projection period, including substitution to other manganese products, switching between steel grades with different manganese contents, and to other elements such as copper, titanium, plastics, and other metals.

With regards to the substitution of EMM to other products, consumers have historically shifted some of their EMM requirements to products, such as ferromanganese. The major determinants of this type of substitution are relative pricing and availability of supplies. For instance, consumers in Japan have tempered demand for EMM to reduce their exposure to Chinese EMM exports. However, Chinese substitution has been limited, due to readily available EMM supplies, Chinese stainless steel producers' preferences for EMM, and Chinese high-grade ore quantities necessary to domestically produce other manganese products are limited.

Historically, EMM has been employed in 200-series chromium-manganese (CrMn) low-nickel steels during times of high nickel prices. The market share of 200-series steels to total stainless steel production has increased significantly in recent years due to the cost advantages over pricier, high nickel-content steels. If lower nickel prices result in a greater share of 300-series steels relative to 200-series over the projection period, demand for EMM would be adversely affected.

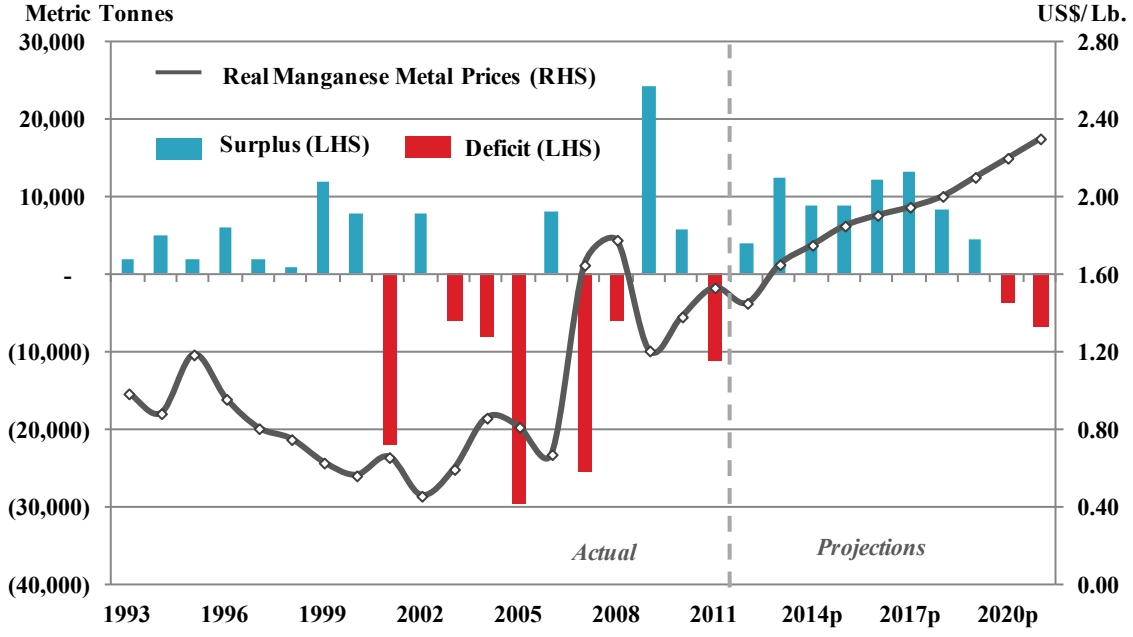
Given the importance of cost reduction in applications where manganese is used in lieu of nickel, copper is one of the main substitutes for manganese. Plastics also may continue to be an increasingly important substitute application for household steel items and aluminum canning. Lastly, titanium can be a substitute for manganese in some niche applications, though its higher cost would likely limit such substitution.

EMM Supply and Demand Outlook

Global supply and apparent demand of electrolytic manganese have historically been closely aligned. Increased demand for electrolytic manganese metal between 2000 and 2007 ushered in a substantial and sustained shift in the market's dynamics. The pace of new supplies accelerated as a result. This overcapacity effectively kept a ceiling on prices, which ultimately led to plant closures outside of China. As of 2010 Chinese EMM capacity was up nearly 16-fold since the beginning of the last decade at 2.2 million mt. Meanwhile, only one other country was producing EMM compared to three in 2000. Over this 11 year period the market recorded deficits on an annual basis for more than half of those years. However, the scope of these supply shortfalls has been fairly modest, averaging less than 2 weeks of demand over those six years.

Base Case: Real Manganese Metal Prices and World Supply and Demand Balance

Annual, Projected through 2021p



Source: CPM Group, Company Reports, Industry Sources

Over the past couple of years, restrictive export Chinese policies have led to significant amounts of smuggling to evade export duties. The Chinese government is expected to continue to step up its enforcement of the EMM industry. After more than a decade of primarily depending on Chinese EMM production, CPM Group expects new EMM capacity may come on-stream between 2013 and 2016 from five Probable Projects in the Ukraine, Gabon, Kazakhstan, Mexico, and the United States. Other possible sources of EMM supply could come from development projects in Canada, Finland, and United States. During the second half of the forecast period China could become a small net importer at times.

EMM Price Forecast

The need for new capacity outside of China and the rising cost structure of existing capacity in China are the primary factors driving CPM Group's price forecast. Present operating costs and projected costs going forward are not supportive of prices reverting back to their historical averages of $0.45 to $0.85 per pound. While CPM Group's forward supply curve incorporates supplies from new producers outside of China, Chinese EMM output is still expected to account for nearly 90% of global supplies in 2021. For Chinese producers to maintain current production levels, significant capital investments need to be made to upgrade existing technology and to preserve domestic ore resources.

Over the 10-year period prices may rise at a CAGR of 4.8%, accelerating toward the end of the period to allow for more supplies from marginal cost producers. Between 2012 and 2016, real prices may average $1.72 and rise roughly 23% during the second half of the projection period to average $2.11 on an annual basis. Over the next 10 years real electrolytic manganese metal prices are forecast to average $1.92 per pound, reaching an annual high of $2.30 in 2021. This is nearly double the annual average price over the last 10 years.

Real Annual Manganese Flake Prices

Base = 2011 U.S. Dollars

Per Pound

	Base Case
2012p	**$1.45**
2013p	**$1.65**
2014p	**$1.75**
2015p	**$1.85**
2016p	**$1.90**
2017p	**$1.95**
2018p	**$2.00**
2019p	**$2.10**
2020p	**$2.20**
2021p	**$2.30**
Averages	
2012p - 2021p	**$1.92**

Source: CPM Group

Overview of Electrolytic Manganese Dioxide Market

Electrolytic manganese dioxide consumes roughly 2% of global manganese supplies. Similar to the EMM market, the majority of global EMD capacity is located in China. However, production capacity is more regionally diverse with the United States (14.8%), Japan (8.0%), South Africa (7.1%), and Greece (5.4%) accounting for more than a third of total capacity in 2010.

EMD is mostly used in alkaline and other small-scale, consumer electronics batteries. Alkaline batteries are a low growth end-use, expected to track well below GDP growth rates over the forecast period. In small-scale electronics, EMD use is projected at historical growth rates of 4%. The highest potential growth segment for EMD is in large-scale rechargeable batteries used in electric vehicles and electronics. At present, the rechargeable manganese battery segments account for less than 10% of total EMD demand. As electric vehicles penetrate the auto market over the coming decades, EMD demand stands to benefit. Demand from rechargeable batteries could reach 25% by 2021, according to CPM Group estimates. There remains a large degree of uncertainty in the electric vehicle industry, however. Thus, CPM Group has accounted for this uncertainty by including an alternative high case demand scenario, in which electric vehicles account for a greater share of total vehicle sales than in the base case.

EMD demand is projected to rise from more than 349,000 mt in 2011 to nearly 608,000 mt in 2021, a 5.7% CAGR. In contrast to EMM demand projections, EMD demand growth is expected to accelerate after 2015, reflecting higher market penetration rates by electric vehicles. From 2016 to 2021 EMD demand is expected to grow at a CAGR of 6.1%, compared to a 5.3% CAGR from 2011 to 2016.

The **CPM Group Electrolytic Manganese Market Outlook** is part of a series of long-term studies of ferroalloy metals markets. These studies are used by **producers** for strategic planning and in the preparation of technical reports. In addition, **consumers**, **institutional investors** and **physical traders** supplement their internal research with CPM Group's comprehensive analyses, conclusions, and projections. The reports also serve as authoritative reference guides for electrolytic manganese market statistics.

About CPM Group:

CPM Group is the world's premier commodities research and consulting company. The company is heavily focused on precious, industrial, and specialty metals, in addition to undertaking research and analysis across all commodities markets. In the ferroalloy industry CPM Group has developed an unsurpassed expertise in molybdenum, vanadium, manganese, and chromium, as well as other minor metals. CPM Group provides a suite of research and consulting services related to the financial management of commodities exposure, including fundamental market research and analysis, consulting and advisory services, commodities management and asset management services, and corporate finance advisory. Founded in 1986, CPM Group has extensive experience in commodities research, trading, banking, and financing. CPM Group is known for its research and analysis of the metals markets, its overall economic analysis of commodities markets, and its expertise in financial engineering, using derivatives to structure optimized positions for commercial hedgers and institutional and high net worth individual investors.

CPM Group clients include major producers, processors, market intermediaries, and industrial users of commodities. Institutional investors engaged in investing in commodities and commodities producing companies retain CPM Group for research, analysis, and advice on managing their financial exposure to these markets. Institutional investors, hedge funds, private equity funds, and family offices rely on CPM Group for accurate analyses of commodities markets. Central banks; foreign ministries; and agencies involved in attracting foreign direct investment, strategic metals policies, energy and agriculture; and sovereign wealth funds have drawn on CPM Group's knowledge and experiences since the 1980s in these areas.

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