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COMMENTARY

Towards a More Sustainable Chinese Aluminum Industry

By Louis B. Schwartz and Ryan N. Hodum

RECOGNIZING THE CONUNDRUM

The primary aluminum industry is one of the six largest users of energy in China. Out of the nearly 3.43 trillion kilowatt-hours (kWh) of electric power consumed in China in 2008, China's primary aluminum industry accounted for more than 5 percent of the total, or approximately 182 billion kWh. On average, power consumption per metric ton (MT) of output of primary aluminum in China was approximately 14,500 kWh/MT as of early 2008, not much higher than the world average.[1] As of early 2008, with then current technology, energy costs accounted for roughly 35 percent of the total cost per MT of primary aluminum production in China.

China's aluminum smelting capacity has increased dramatically from approximately 2 million tons per year in 1997 to nearly 20 million tons per year as of the end of 2009. China's output of primary aluminum has grown from approximately 6.5 million MT in 2004 to approximately 13 million MT in 2008. Because of the repercussions of the economic downturn resulting from the worldwide financial crisis beginning in the fall of 2008, the 2009 aluminum output (~12.6 million MT) was slightly less than 2008 output—as of mid-year 2009 approximately 41 percent of China's aluminum smelting capacity was idle.[2] However, by mid-2010, China's output of primary aluminum had rebounded sharply with a 45.6 percent increase year-on-year. Chinese aluminum output is now on track to exceed 16 million MT for all of 2010.

Though China now both produces and consumes approximately one-third of the world's aluminum, at 6.5kg/person (as of 2007), China's per capita consumption is only 25 percent of per capita consumption in the United States; this presages continued growth in both aluminum production and energy consumption by the Chinese aluminum industry in the years ahead.

The growing power requirements of the fast developing primary aluminum industry over the past decade have contributed to the rapid development of the power industry in China, which remains dominated by coal-fired power plants.[3] For many years power usage in the Chinese primary aluminum industry was exacerbated by preferential power pricing at the local level—a technique widely used by local governments to entice development of new smelters. An important consequence of the heavy consumption of power by the Chinese primary aluminum industry has been the drive by aluminum producers to build their own "captive" coal-fired power plants to serve their aluminum operations.

In recent years there have been a large number of Chinese aluminum smelters that have integrated coal mining, power production and aluminum smelting; this is particularly true of Shandong and Henan provinces, which are rich in coal deposits.[4] These integrated coal/power/smelting operations are said to have a 50 percent

cost advantage over non-integrated smelters. China's large state-owned aluminum smelters, however, almost universally are not integrated and instead rely on purchasing their power requirements from utilities; and the price that utilities charge is not market based, but rather is distorted by central government policies that sacrifice rational energy markets to continued economic growth. The lack of a strong market to determine power prices also is a significant contributing factor to chronic overcapacity and excessive energy use in the aluminum industry. The policies promoting aluminum production highlight China's growth conundrum—protecting economic growth through wasteful energy consumption increases environmental degradation and undercuts energy security, both of which threaten sustained economic growth in the long run.

ADDRESSING THE ENVIRONMENTAL AND ENERGY TOLL OF THE CHINESE ALUMINUM INDUSTRY

The severe challenges that rapid economic growth poses to the country's environment and energy security have been the drivers of the Chinese government's national policy to reducing pollution emissions and conserve energy (*jieneng jianpai*), which is putting pressure on the Chinese aluminum industry to become more energy efficient and have less impact on the environment. Specifically, Beijing has implemented a series of tax, investment, and energy pricing policies to reduce the energy and environmental impact of the Chinese aluminum industry.

These new policies complement earlier efforts to clean up this industry. For example, the massive ramp-up of smelting capacity in China beginning in the late 1990s was accompanied by a steady, concerted and successful effort to mothball the environmentally and energy unfriendly mid-20th Century Soderberg aluminum smelting technology that predominated in the People's Republic of China for most of its first 50 years.

A suite of other measures is wrestling greater efficiency out of the Chinese primary aluminum industry. The February 22, 2008 notice from the National Development and Reform Commission (NDRC), which directed the elimination of all preferential power rates, has had the effect of increasing power costs for the Chinese aluminum smelting industry, though the downturn in the economy in 2008 created slippage in this important policy. The national goal of reducing energy consumption per 10,000 Yuan of GDP by 20 percent during the 11th Five-Year Plan period (2006-2010) has set concrete objectives throughout the economy. In early June 2009 the Chinese government issued the *Notice of the State Council Concerning Adjusting the Equity Proportion of Fixed Asset Investment Projects.* The June 2009 notice further increases the equity requirements for fixed asset projects that are characterized by heavy energy consumption, including primary aluminum smelting. In 2004 the Chinese government increased the equity proportion for new aluminum smelter projects from 20 to 35 percent; the June 2009 notice raises the equity portion of new investment to 40 percent.

An important part of the drive to wrestle energy and environmental savings from the Chinese aluminum industry is reigning in the chronic over-capacity that exists in the industry, which in turn has resulted in such irrational (from a macroeconomic, energy and environmental standpoint) behavior as exports of primary aluminum. This overcapacity also showed up recently in massive increases in fabricated aluminum product exports, which has unleashed a rash of anti-dumping and anti-subsidy investigations from Canada to Australia. It is significant that after China's largest aluminum producer Chinalco undertook significant measures to reduce its energy consumption after it entered into the NDRC's "1000 Enterprises Energy Conservation Program." (See Box 1).

Box 1. PROFILE OF CHINA'S ALUMINUM GIANT CHINALCO

The Aluminum Corporation of China (Chinalco) has grown to be the world's second largest refiner of alumina and the world's third largest producer of primary aluminum. As of the end of 2007 Chinalco had assets totaling 201.4 billion Yuan (up from 30 billion Yuan in 2001) and an operating income of 131.7 billion Yuan. For the second year in a row in 2007 Chinalco's profits exceeded 20 billion Yuan. Chinalco is among the top ten Chinese enterprises in terms of the number of patents it owns.

From 2001 through the spring of 2009 Chinalco cumulatively invested nearly 10 billion Yuan in science and technology research and development, over 5 billion was spent over the last three years on energy conservation and emission reductions in the company's bauxite mining, alumina refining, primary aluminum smelting and fabricated aluminum products processing operations.

With respect to its aluminum smelting operations, more advanced controlling technologies for the company's pre-baked aluminum smelting processes, which Chinalco developed itself, have been implemented in the corporation's ten branches. This new technology alone can reduce energy consumption per metric ton (MT) of primary aluminum produced by 140 kWh. Particularly since 2006, when Chinalco joined the *1000 Enterprises Energy Conservation Objectives Undertaking* initiated by the NDRC, it has actively sought to close the gap in operations between itself and world-class aluminum enterprises and worked to conform its operations to world-class standards. As part of this effort, Chinalco entered into letters of responsibility with the corporation's nearly 100 enterprises, setting goals and distributing concrete terms of responsibilities across the the entire organization.

According to Chinalco's 11th *Five Year Plan Energy Conservation and Emissions Reductions Objectives*, by 2010 (as compared with 2005), the total amount of sulfur dioxide emissions are to be reduced by 10 percent, energy consumption per 10,000 Yuan of industrial value-added is to be 20 percent lower[4], the volume of water discharge per 10,000 Yuan of value added is to decline by 30 percent, overall utilization rates of mineral resources are to increase by 5 percent and overall utilization of industrial solid waste is to increase by 5 percent. On June 17, 2009 the National Audit Office released its audit on Chinalco as part of its random sampling of the top 1000 enterprises in China. The outcomes of Chinalco audit, while confirming that the company has made noticeable progress in its efforts to conserve energy and reduce emissions, also pointed out instances where Chinalco subsidiaries have not completed certain energy conservation and emissions reductions tasks; for example, there are 31 boilers at 13 Chinalco subsidiaries which have not completed desulphurization upgrades and that Baotou Aluminum Co., a branch of Chinalco, saw its energy consumption per unit of primary aluminum produced rise by 1.83 percent. A spokesperson for Chinalco said that in response to the audit report, Chinalco has made investigations into these situations and has formulated a follow-up plan. With respect to Baotou Aluminum's increase in per unit energy consumption, Chinalco reports that the company spent 1.66 billion Yuan in 2008 to install the most advanced 400KA aluminum smelting technology and to shut down Baotou's outdated 135KA primary aluminum and related carbide production lines, both of which consumed much greater amount of energy.

Box 1. CONTINUED

Chinalco is also operating and/or putting together a series of secondary aluminum production lines, which cumulatively save 2.8 billion Kwh of energy compared to the same output at Chinalco's primary aluminum smelting operations; the secondary lines include Phase I of Chinalco's Qingdao 200,000 tons per year secondary aluminum facility and the Guangdong, Nanhai alloy project, which produces secondary aluminum from the scrap aluminum generated by the sizable Chinese aluminum processing (particularly extrusion) industry concentrated in Nanhai.

Also on the horizon are new regulations that require investors in new fixed asset projects to submit a detailed energy efficiency blueprint; any project that does not develop an energy efficiency program for a proposed new investment will not be allowed to proceed with the investment. Besides targeting primary aluminum smelting at the initial development stage, other initiatives target primary aluminum smelters that are already operating. One significant stumbling block for Beijing to begin to achieve its goal of reducing energy consumption per unit of GDP by 20 percent by 2010 is the resistance put up by local governments who are more interested in fostering economic development in their regions, often by encouraging the establishment of more energy and resource intensive industries. As new aluminum smelting capacity grows, however, China continues to close the most energy-intensive smelters; on August 8, 2010 the Ministry of Industry and Information Technology published a list of more than 2,000 energy-intensive plants that are required to close. That list includes seventeen small aluminum smelters (ranging from 60 to 90 kiloamperes) with a combined capacity of more than 420,000 tons per year. The August 2010 Ministry of Industry and Information Technology order to close energy intensive plants may allow China to realize its 2010 goal on time, despite having just a 14.4 percent improvement in the first five years of the effort.

EFFECTIVE USE OF TAX POLICY: LIMITING INCENTIVES TO OVERPRODUCTION OF ALUMINUM

The negative effects on China's energy and environmental policies of large-scale exports of primary aluminum caused the Chinese government to reduce Value Added Tax (VAT) rebates on exports of primary aluminum from China beginning in 2004. However, even after VAT rebates on primary aluminum exports were reduced to zero the exports of primary aluminum continued, which led the Chinese government to impose export tariffs. To avoid these tariffs, Chinese aluminum producers used exports of fabricated aluminum products, which then sparked the Chinese government in July 2007 to change VAT rebates for exports of certain categories of processed aluminum products, such as aluminum profiles. When Chinese producers responded to those tariff changes by beginning to export large quantities of minimally processed aluminum products, such as tube products, as a means of avoiding tariff and VAT rebate policies respecting primary aluminum, the Chinese government was forced to further regulate those categories as well. This in turn finally resulted in a decline in exports of such minimally processed products. The large number of anti-dumping and anti-subsidy investigations and actions by

A glimpse inside some small aluminum plants in China. Photo Credit: Louis B. Schwartz and Ryan N. Hodum

nations around the world in recent years reflect in part the incompleteness of Beijing's use of tariff policy to reign in the Chinese aluminum industry. The years of cat-and-mouse games between regulators and the aluminum exporters underscores the truth of the Chinese aphorism: "you have policies, we have countermeasures" (*ni you zhengce, women you duice*).

THE ROLE OF PREFERENTIAL POWER PRICING: A LEVER TO LIMIT OUTPUT AND ENFORCE ENVIRONMENTAL CONTROLS?

In mid-July 2009, the State Electricity Regulatory Commission, NDRC and the State Energy Bureau jointly issued the *Notice on Relevant Questions Concerning Perfecting the Work of Demonstration Sites for Direct Sales to Power Users by Power Generating Companies*, marking a new stage in the reform of the electric power industry and a new effort to use power pricing to control aluminum production, among other industries. The *Notice* has the potential to become an important route to rationalizing the Chinese aluminum industry, in part by favoring larger users of electricity that have more advanced technology, and weeding out the smaller, less efficient and less environmentally friendly companies. According to the *Notice* the price of power will be separated into the price of on-grid power and the price of transporting the power and large users may directly negotiate the on-grid price with power producers. With respect to the price for the transportation of power, the *Notice* provides for a 10 percent discount for 110 kV power transportation and a 20 percent discount for 220 kV power transport.

Industry insiders say that the effect of the implementation of the *Notice* is to greatly reduce the cost of production of large power users. On the other hand, small and mid-sized companies will not be able to avail themselves of the benefits of the *Notice*, which will result in a growing discrepancy between the total cost of production of small and mid-sized enterprises and the total cost of production of the larger enterprises benefiting from the *Notice* (provided that the policymakers in Beijing are able to enforce a suspension of preferential power pricing often afforded to aluminum smelters by local governments). The goal of the planners is that this discrepancy will lead to the

gradual closing of the smaller, less efficient and less environmentally friendly plants. Based on the current average price per kilowatt-hour for industrial users averaging 0.6Yuan/kwh, at a 10 to 20 percent discount, the larger enterprises will have a price benefit of between 0.06 Yuan and 0.12 Yuan. According to one analysts' calculation, where the average power use per MT of primary aluminum is 14,500 kWh, the cost of power accounts for approximately 35-40 percent of total production costs. If the power discount per kWh is 0.06 Yuan, then the cost to produce each MT of primary aluminum for these large-scale aluminum smelters will be 870 Yuan less than today; at a 20 percent discount the savings would be more than 1,700 Yuan/MT.[5]

SECONDARY ALUMINUM: A PATH TO GREATER SUSTAINABILITY IN THE CHINESE ALUMINUM INDUSTRY?

The reduced energy consumption and related lesser impact on the environment of the use of secondary aluminum are well documented. Producing a MT of secondary aluminum from scrap aluminum requires approximately 5 percent of the energy consumption required to produce a MT of primary aluminum.[6] In 2007, China produced a total of 2.849 million MT of secondary aluminum, a 17 percent increase over secondary aluminum output in 2006; this level of output of secondary aluminum resulted in a savings of 19.27 million MT of coal equivalents and 160 million MT of water. The level of production of secondary aluminum in 2006 also resulted in 141,000 MT less of sulfur dioxide emissions and 68 million MT of avoided solid waste emissions.[7]

In 2007 China's consumption of secondary aluminum accounted for 22.9 percent of total aluminum consumption (12.44 MT of primary aluminum was produced in 2007), which is lower than the world's average consumption of secondary aluminum of 50 percent. If by the year 2020, China is able to increase its consumption of secondary aluminum from 22.9 to 60 percent, the country could annually save 36.4 million MT of bauxite, 136.5 billion kWh of energy, and 91 million cubic meters of water (taking into consideration the growth in consumption and output of primary aluminum to 2020).

Wang Xihui—a representative to the National People's Congress, the General Manager of the Henan branch of Chinalco and the Chairman of the Non-Ferrous Metals Association of Henan Province—recently remarked that China needs to increase its utilization of secondary aluminum and that the greater use of secondary aluminum is a "green project" which will help reduce energy consumption and raw materials and cut down on pollution. In order to increase the amount of secondary aluminum output in China, it will be necessary for China to build a secondary aluminum recovery and utilization system, while increasing automation, the quality of equipment, environmental compliance, and further developing an effective network of scrap recovery, distribution and re-utilization. To accomplish these goals it will be necessary for the government to provide policy, financial and technological assistance to China's still nascent secondary aluminum industry.

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ENDNOTES

[1] One important goal for the Chinese primary aluminum industry is to put in place the technology that would enable Chinese aluminum smelters to reduce energy consumption per metric ton of primary aluminum from an average of 14,500 kWh to an average of 12,000 kWh. Technological upgrades such as these alone would reduce overall energy consumption in the primary aluminum industry by approximately 19.5 billion kWh/year or more than 10 percent of current energy consumption by the Chinese primary aluminum industry.

[2] The economic downturn in China caused by the worldwide financial crisis both has aggravated the environmental challenges posed by the primary aluminum industry (through the reinstitution of preferential power pricing policies directed at the primary aluminum industry) and ameliorated the problem by causing China's primary aluminum industry to idle a substantial amount of capacity, most of which is the least efficient of China's aluminum smelting capacity. The slowdown in output of primary aluminum in turn may result in a reduction in energy consumption of approximately 28 billion kWh by the Chinese primary aluminum industry in 2009, though an economic meltdown is not the most ideal way for the Chinese to reduce emissions and conserve energy.

[3] Compared with conditions overseas, the Chinese primary aluminum smelting industry relies to a much greater extent on the use of coal-fired power plants for the power required to smelt aluminum (by one estimate 70 percent of power used by the Chinese aluminum industry is coal-fired).

[4] With respect to its energy consumption, Chalco's overall energy consumption per unit of alumina refined has declined by 21.39 percent through the end of 2007, while its overall energy consumption per unit of primary aluminum produced declined by 3.57 percent. Taking all of its subsidiary companies as a whole, the company's rate of reuse of industrial water rose from 87.68 to 90.60 percent from 2006 to 2007 and 80 percent of its alumina refineries now are achieving zero discharges of industrial waste water, which results in a decline of wastewater discharge totaling 33.77 million tpy. In 2007 Chinalco increased its desulfurization by 98,000 MT/year and increased its rate of removal of smoke and dust from 85.1 to 99.1 percent.

[5] One estimate is that there is in excess of 2 million tons per year of aluminum smelting capacity that is produced in facilities that integrate coal production, power output and aluminum smelting.

[6] This takes into account the entire life cycle of primary aluminum production, including bauxite mining, alumina refining and primary aluminum smelting.

[7] In 2008 China produced a total of 2.7 million MT of secondary aluminum (down from 2.849 million MT of secondary aluminum produced in 2007) and in 2009 China's secondary aluminum output rose to ~2.97 million MT. Because China produced a total of 40 million MT of primary aluminum between 1990 and 2004 and the products produced and consumed in China since the 1980's have reached the end of their useful lives, it is expected that the rate of growth of scrap aluminum recovery will increase to 8 percent from ~6 percent beginning in 2010.