



2011 Minerals Yearbook

LIME

LIME

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In 2011, the U.S. economy continued its slow recovery from the 2008–09 recession. Lime production in the United States was 19.1 million metric tons (Mt) (nearly 21.1 million short tons), an increase of 838,000 metric tons (t) (924,000 short tons) from that of 2010. The increase was mostly in metallurgical uses such as ore concentration and steelmaking. The value of U.S. lime production was \$2.13 billion (table 1).

The term lime as used throughout this chapter refers primarily to six chemicals produced by the calcination of high-purity calcitic or dolomitic limestone followed by hydration where necessary. There are two high-calcium forms—high-calcium quicklime (calcium oxide, CaO) and high-calcium hydrated lime [calcium hydroxide, Ca(OH)₂]. There are four dolomitic forms—dolomitic quicklime (CaO•MgO), dolomitic hydrate type N [Ca(OH)₂•MgO], dolomitic hydrate type S [Ca(OH)₂•Mg(OH)₂], and refractory dead-burned dolomite (CaO•MgO). The terms “type N” and “type S” refer to “Normal hydrated lime” and “Special hydrated lime” that are differentiated primarily by the compounds’ plasticity (ability to retain water) and oxide content. There are also air-entrained versions of these hydrates designated as “type NA” and “type SA.”

At present, all commercially produced lime in the United States is manufactured from limestone or dolomite, but lime also can be produced from a variety of calcareous materials, such as aragonite, chalk, coral, marble, and shell. It also is regenerated (produced as a byproduct) by paper mills, carbide plants, and water-treatment plants. Regenerated lime, however, is beyond the scope of this report.

Legislation and Government Programs

In 2009, the U.S. Environmental Protection Agency (EPA) published a rule for the mandatory reporting of greenhouse gases (GHG) from large GHG emissions sources in the United States. Implementation of 40 CFR Part 98 is referred to as the Greenhouse Gas Reporting Program (GHGRP). In general, the threshold for reporting is 25,000 t or more of carbon dioxide (CO₂) equivalent per year. In response to a call for information and public comments, representatives of the U.S. lime industry submitted comments indicating their concerns that the public release of some of the required data elements could cause competitive harm. Examples of the types of data the industry was concerned about were amounts and types of fuel combusted each year, heat input capacity of lime kilns, and monthly amounts of lime sold. In August, the EPA published a final rule deferring reporting of several data elements under the GHGRP, until March 2013 in some cases, and March 2015 in others. The agency would use the time to make final decisions on what types of data would be afforded protection as confidential business information (National Lime Association, 2011; U.S. Environmental Protection Agency, 2011).

Production

Domestic production data for lime were derived by the U.S. Geological Survey (USGS) from a voluntary survey of U.S. operations. The survey was sent to primary producers of quicklime and hydrate, but in order to avoid double counting, it was not sent to independent hydrators that purchase quicklime for hydration. Quantity data were collected for 28 specific and general end uses, and value data were collected by type of lime, such as high-calcium or dolomitic. Because value data were not collected by end use, value data listed in table 3 were determined by calculating the average value per metric ton of lime sold or used for each respondent and then multiplying that figure by the quantity of lime that the respondent reported sold or used for each end use. Table 3 lists the total quantity sold or used for an end use and the total value of the quicklime and hydrate sold or used for that end use calculated as described above. A similar methodology using average hydrate values was used to calculate the value of hydrate sold and used listed in table 4.

In 2011, of the 85 operations that were canvassed, responses were received for 75 plants, representing 94% of the total sold or used by producers. Production data for the nonrespondents were estimated based on prior-year production figures and other information or were included with data reported for other operations.

Lime is a basic chemical that was produced as quicklime in 29 States and Puerto Rico. During 2011, quicklime was produced at 76 lime plants, and included 31 plants with collocated hydrating plants. Hydrated lime also was produced at 15 standalone hydrating facilities, including 3 plants where the kilns had been shut down and hydrate was manufactured from quicklime produced offsite. These numbers do not necessarily agree with the number of plants reported in tables 1 and 2 because, for data collection purposes, some company operations have been combined at the respondent’s request. In a few States with no quicklime production, hydrating plants used quicklime shipped from other States. There were also a small number of slurry plants where lime was converted to liquid form by the addition of water prior to sale; this is sometimes called milk-of-lime. In addition to stationary slurry plants, there were mobile hot lime slurry production systems designed to slake quicklime or slurry hydrated lime to the percent solids required for each job. States with production exceeding 2 Mt were, in descending order, Missouri, Kentucky, and Alabama; States with production between 1 and 2 Mt were, in descending order, Ohio, Texas, Pennsylvania, and Nevada.

Total lime sold or used by domestic producers in 2011 was 19.1 Mt, an increase of nearly 5% compared with that of 2010. Production included the commercial sale or captive consumption (described by the term “used”) of quicklime,

hydrated lime, and dead-burned refractory dolomite. Data were incomplete on production of hydrated lime because some producers do not report data on downstream hydrating plants. Traditionally, most U.S. lime production sold and used is in the form of high-calcium quicklime. In 2011, compared with the revised figures for 2010, the production of high-calcium quicklime and dolomitic quicklime increased by about 5% and 4%, respectively. High-calcium quicklime production totaled 13.9 Mt (15.3 million short tons), and accounted for 73% of total production. The production of high-calcium hydrate increased by 5%. Production of dolomitic hydrate continued to be adversely affected by the depressed housing and construction markets and decreased by about 4%. Commercial sales increased to 17.7 Mt (19.5 million short tons), and captive consumption increased to 1.43 Mt (1.58 million short tons).

Carmeuse Lime & Stone signed an agreement with BenchMark Energy Corp. to purchase 75,000 gallons of crude glycerin on a weekly basis. Carmeuse planned to use the glycerin as a coal additive at its Black River, KY, coal-fired lime plant. The addition of the crude glycerin, which is a byproduct of biodiesel production, was expected to reduce the emissions of hazardous air pollutants resulting from the burning of coal at the lime plant (PR Newswire, 2011).

Mississippi Lime Co. announced the expansion of hydrated lime production capacity at its Ste. Genevieve, MO, plant, and the installation of a new hydrated lime facility at its Verona, KY, lime plant. These expansions were expected to be in full operation by the fourth quarter 2011. The Verona plant is permitted for a capacity of 150,000 metric tons per year (t/yr) (165,000 short tons per year) of hydrated lime. The Verona plant is located in the Ohio River Valley close to various utility customers. The Ste. Genevieve expansion of about 250,000 t/yr (275,000 short tons per year) was expected to be used to provide hydrated lime to both the chemical industry and utility customers. These expansions included new technology to manufacture a high performance hydrated lime designed for improved sulfur dioxide (SO₂), sulfur trioxide (SO₃), and hydrochloric acid (HCl) removal at powerplants (Mississippi Lime Co., 2011).

The former Missouri Lime LLC plant in Bonne Terre, MO, was acquired by FTL Capital LLC in 2010 and renamed Valley Minerals LLC. In 2011, the company announced plans to expand its operations and add additional staff. The facility specialized in products for the steel industry, most of which contain lime, but also some refractory products (St. Louis Business Journal, 2011).

Although the lime industry continued to recover from the severe downturn experienced during the 2008–09 recession, a number of the plants were idle all or part of 2011. These included five Lhoist North America plants (Alabaster, AL; Douglas, AZ; Tenmile, ID; Grantsville, UT; and the hydrating plant at Belen, NM) and two Carmeuse Lime & Stone plants (South Chicago, IL; and Winchester, VA). Some of these plants are quite old and may never reopen, at least in their current form. Carmeuse and Lhoist are in the process of replacing some old kilns with new kilns at certain plants, but the capacity of the new kilns represented only a small part of the total idle capacity of the plants listed above.

The list of the top 10 producing U.S. lime companies was essentially unchanged from that of 2010, with only a change in the number 10 position. At yearend, the top 10 companies were, in descending order of U.S. lime production, Carmeuse, Lhoist, Graymont Ltd., Mississippi Lime Co., United States Lime & Minerals, Inc., Western Lime Corp., Martin Marietta Magnesia Specialties LLC, Southern Lime Co., ArcelorMittal USA Inc., and Cheney Lime & Cement Co. These companies reported production from 41 lime plants and 12 separate hydrating plants and accounted for nearly 92% of the combined commercial lime sales and 87% of total lime production.

Consumption

In 2011, the U.S. economy continued its slow recovery from the longest recession since the Great Depression of the 1930s. Steelmaking led the recovery in lime consumption recording an increase in consumption of nearly 10% compared with that of 2010. The approximate breakdown of lime consumption by general end-use sectors was as follows: 38% for metallurgical uses, 31% for environmental uses, 22% for chemical and industrial uses, 8% for construction uses, and 1% for refractory dolomite (table 3). These end-use data were based on lime sold and used by domestic producers and do not include lime imports. Consumption for metallurgical uses continued to be the main driving force behind the lime industry's recovery from the downturn experienced during the 2008–09 recession. The increase in consumption for metallurgical uses (ferrous and nonferrous) accounted for nearly 87% of the total increase in lime consumption in 2011. Consumption in the other major market sectors—chemical and industrial, construction, and environmental—was essentially unchanged compared with that of 2010.

Commercial sales accounted for 91% of total lime consumption and 92% of domestic production. Captive lime accounted for the remainder of consumption and was used in the production of steel in basic oxygen furnaces (BOF), magnesia production, precipitated calcium carbonate production, sugar refining, and refractories (dead-burned dolomite). Almost all data on captive lime consumption are withheld to avoid disclosing company proprietary information. As a result, table 3 lists the total quantity and value of lime by end use. End uses with captive consumption are listed in footnote 4 of the table.

In steel refining, quicklime is used as a flux to remove impurities, such as phosphorus, silica, and sulfur. The steel industry accounted for about 31% of lime sold by domestic lime companies and the lime produced and used by ArcelorMittal USA from its captive lime plant. The U.S. steel industry is still recovering from the effects of the 2008–09 recession, which resulted in a 36% decrease in steel production in 2009 compared with that of 2008. In 2010, demand picked up significantly, and steel production increased by 38% compared with that in 2009. In 2011, the recovery continued, albeit at a slower rate, and steel production increased by 7% (World Steel Association, undated). As would be expected, lime consumption (from domestic sources) for steelmaking tracked these increases in steel production closely, increasing by 39% in 2010 and by 10% in 2011.

In nonferrous metallurgy, lime is used in the beneficiation of copper ores to neutralize the acidic effects of pyrite and other iron sulfides and to maintain the proper pH in the flotation process. Lime is used to process alumina and magnesia, to extract uranium from gold slimes, to recover nickel by precipitation, and to control the pH of the sodium cyanide solution used to leach gold and silver from the ore. Gold and silver are recovered using heap leaching and by conventional milling and subsequent leaching of the slurry. The sodium cyanide solution dissolves gold from the ore and forms a stable gold-cyanide complex, and the gold can then be separated through the use of highly activated carbon. Heap leaching involves crushing the ore, mixing it with lime for pH control and agglomeration, and stacking the ore in heaps on specially prepared pads for treatment with cyanide solution. Lime is used to maintain the pH of the cyanide solution at a level between 10 and 11 to maximize the recovery of precious metals and to prevent the creation of hydrogen cyanide. Lime consumption data for these various uses (aluminum and bauxite processing, concentration of copper and gold ores, and unspecified nonferrous uses) are combined to avoid disclosing company proprietary data and are reported in table 3 under metallurgical, nonferrous metallurgy. In 2011, lime consumption in nonferrous metallurgy increased by nearly 18% to 1.33 Mt, which brought this market sector close to its peak consumption of 1.37 Mt reached in 2007 and 2008. Although specific data are not collected on lime consumption for copper recovery or for gold recovery, they make up a large part of the nonferrous metallurgy market. An increase in Nevada gold production (up by 7% compared with that of 2010) was likely the leading factor behind the increase in this market segment (George, 2012). Copper flotation concentrate production, in comparison, decreased by about 2% in 2011 (Edelstein, 2012).

Environmental remediation uses of lime in mining include treatment of the tailings that result from the recovery of precious metals, such as gold and silver. These tailings may contain elevated levels of cyanides, and lime is used to recover cyanides in such treatment processes as alkaline chlorination, Caro's acid (H_2SO_5), Cyanisorb™, and sulfur dioxide/air.

Lime is used, generally in conjunction with soda ash, for softening municipal and plant process water. This precipitation process removes bivalent soluble calcium and magnesium cations (and to a lesser extent, ferrous iron, manganese, strontium, and zinc) that contribute to the hardness of water. This process also reduces carbonate alkalinity and total dissolved solids. Lime consumption for drinking water treatment was essentially unchanged compared with that of 2010.

In sewage treatment, the traditional role of lime is to control pH in the sludge digester, which removes dissolved and suspended solids that contain phosphates and nitrogen compounds. Lime also aids in clarification and in destroying harmful bacteria. The leading use in sewage treatment is to stabilize the resulting sewage sludge. Sewage sludge stabilization, also called biosolids stabilization, reduces odors, pathogens, and putrescibility of the solids. Lime stabilization involves mixing quicklime with the sludge to raise the temperature and pH of the sludge to minimum levels for a

specified period of time. In 2011, lime consumption for all sludge treatment increased by 16% compared with that of 2010.

In FGD systems serving coal-fired powerplants, incinerators (most are waste-to-energy powerplants), and industrial plants, lime is injected into the flue gas to remove acidic gases, particularly SO_2 and HCl. It also may be used to stabilize the resulting sludge before disposal. Many FGD systems at utility powerplants are now designed to produce byproduct gypsum from the SO_2 emissions. This byproduct material is suitable for use in manufacturing gypsum wallboard, as an additive in portland cement, and as a soil amendment in agriculture. Hydrated lime may be used in another FGD-related market—to control SO_3 emissions from selective catalytic reduction (SCR) systems installed at powerplants to control emissions of nitrogen oxides (NOx). Utility powerplants were by far the largest consumers of lime for FGD and accounted for 92% of the total FGD lime market in 2011. Incinerators, industrial boilers, and other FGD uses accounted for the remaining 8%. In 2011, lime consumption in all FGD markets increased by 136,000 t or about 4% compared with that of 2010. All of the increased was in the utility powerplants sector. The combined consumption by incinerators and industrial boilers was unchanged. The use of hydrated lime in FGD treatment in 2011 increased by 10% to 173,000 t, the majority of which would have been used to treat SO_3 emissions from SCR systems at utility powerplants.

Lime is used by the pulp and paper industry in the basic Kraft pulping process where wood chips and an aqueous solution (called liquor) of sodium hydroxide and sodium sulfide are heated in a digester. The cooked wood chips (pulp) are discharged under pressure along with the spent liquor. The pulp is screened, washed, and sent directly either to the paper machine or to the bleaching plant. Lime is sometimes used to produce calcium hypochlorite bleach for bleaching the paper pulp. The spent liquor is processed through a recovery furnace, where dissolved organics are burned to recover waste heat, sodium sulfide, and sodium carbonate. The recovered sodium sulfide and sodium carbonate are diluted with water and then treated with slaked lime to recausticize the sodium carbonate into sodium hydroxide (caustic soda) for reuse. The byproduct calcium carbonate is recalcined in a lime kiln to recover lime for reuse. The paper industry also uses lime as a coagulant aid in the clarification of plant process water. In 2011, consumption for pulp and paper production increased by 12% compared with that of 2010.

Lime is used to make precipitated calcium carbonate (PCC), a specialty filler used in premium-quality coated and uncoated papers, paint, and plastics. The most common PCC production process used in the United States is the carbonation process. Carbon dioxide is bubbled through milk-of-lime to form a precipitate of calcium carbonate and water. The reaction conditions determine the size and shape of the resulting PCC crystals. Lime used for PCC production decreased by 10% compared with that of 2010.

The chemical industry uses lime in the manufacture of alkalis. Quicklime is combined with coke to produce calcium carbide, which is used to make acetylene and calcium cyanide. Lime is

used to make calcium hypochlorite, citric acid, petrochemicals, and other chemicals.

In sugar refining, milk-of-lime is used to raise the pH of the product stream, precipitating colloidal impurities. The lime itself is then removed by reaction with CO₂ to precipitate calcium carbonate.

In road paving, hydrated lime is used in hot mix asphalt to act as an antistripping agent. Stripping is generally defined as a loss of adhesion between the aggregate surface and the asphalt cement binder in the presence of moisture. Lime also is used in cold in-place recycling for the rehabilitation of distressed asphalt pavements. Existing asphalt pavement is pulverized using a milling machine, and a hot lime slurry is added along with asphalt emulsion. The cold recycled mix is placed and compacted by conventional paving equipment, which produces a smooth base course for the new asphalt surface. In 2011, sales of lime for use in asphalt were essentially unchanged compared with the revised figures for 2010.

In construction, hydrated lime and quicklime are used to stabilize fine-grained soils in place of materials that are employed as subbases, such as hydraulic clay fills or otherwise poor-quality clay and silty materials obtained from cuts or borrow pits. Lime also is used in base stabilization, which includes upgrading the strength and consistency properties of aggregates that may be judged unusable or marginal without stabilization. Common applications for lime stabilization included the construction of airfields, building foundations, earthen dams, parking areas, and roads.

Lime sales for soil stabilization tend to be cyclical, especially in large market areas, such as Texas. In soil stabilization, lime competes with cement, cement kiln dust, fly ash, and other additives (liquid enzymes, for example). Choices made by consumers can depend on availability, price, contract specifications, soil chemistry, and State and Federal funding in the case of highway construction projects. Revisions were made to some estimates used in the 2010 data for lime used for soil stabilization, which increased the 2010 total to 1.02 Mt (compared with the original figure of 983,000 t). In 2011, the soil stabilization market continued to be adversely affected by the slow recovery from the recession and by reduced highway spending at the State level. Lime consumed for soil stabilization in 2011 was essentially unchanged compared with the revised 2010 figure.

Hydrated lime is used in the traditional building sector in mortars, plaster, and stucco. Standard cement mortars that include lime exhibit superior workability balanced with appropriate compressive strength, as well as low water permeability and superior bond strength. Lime is a major constituent in exterior and interior plasters and stuccos, enhancing the durability, strength, and workability of these finishes. A small amount of hydrated lime also is used in the renovation of old structures built with lime mortars, which was standard before the development of portland cement mortars. Modern portland cement mortars are incompatible with old lime mortars. Hydrated lime also is used to make synthetic hydraulic lime, which is produced by blending powdered hydrated lime with pulverized pozzolanic or hydraulic materials.

The U.S. Census Bureau collects data on construction spending for residential construction and 16 categories

of nonresidential construction. The annual total value of construction decreased by less than 2% compared with that of 2010 (U.S. Census Bureau, 2012). Most lime sold for traditional building uses is in the form of hydrate (200,000 t of hydrate out of 211,000 t of total lime in 2011). In 2011, sales of lime for traditional building uses decreased by 9% compared with those of 2010. Most of the lime sold for building uses was produced at a few plants in Nevada, Ohio, Texas, and Wisconsin.

A new use for hydrated lime that has been undergoing experiments and field trials is its use as an additive to corn stover (the stalk, leaf, cob and husk remaining in the field following the harvest) to produce a cattle feed that can replace a substantial portion of the grain normally fed to cattle. The hydrated lime makes the corn stover digestible by the cattle after the treated stover was combined with wet distillers grains and solubles. Wet distiller grains is a byproduct of corn ethanol production and is rich in protein. Researchers thought this product could constitute 25% of cattle feed rations (Archer Daniels Midland Co., 2011).

Dead-burned dolomite, also called refractory lime, is used as a component in tar-bonded refractory brick or monolithics manufactured for use in BOF. Refractory brick also is used in the lining of many treatment and casting ladles, in argon-oxygen decarburization and vacuum-oxygen decarburization converters, in electric arc furnaces (EAF), and in continuous steel casting. The data reported in this chapter were rounded to one significant figure to avoid disclosing company proprietary data: unrounded data showed that the production of dead-burned dolomite increased by 7% compared with that of 2010. Magnesita Refractories Co. (formerly LWB Refractories Co.) at its York, PA, plant and Carmeuse at its Millersville, OH, plant were the only significant dead-burned dolomite producers. Although dead-burned dolomite is the primary form of lime used in refractories, hydrated lime may be used to produce silica refractory brick used to line industrial furnaces.

Prices

The average values per ton for the various types of lime are listed in table 5. All value data for lime are reported by type of lime produced—high-calcium quicklime, high-calcium hydrate, dolomitic quicklime, and dolomitic hydrate. To avoid revealing company proprietary data, value data for dead-burned dolomite are included with the averages for all types.

Most of the lime price figures for 2010 were revised, mainly as a result of correcting administrative errors in the dolomitic quicklime sales data. All lime prices increased in 2011, compared with the revised figures for 2010. The increases ranged from about \$4 to \$5 per metric ton for quicklime sold to about \$3 to \$7 per ton for hydrate sold. The following average values are compared with those of 2010. The average value for all types of lime sold increased by 4% to \$110.10 per ton (\$99.90 per short ton). The average value for high-calcium quicklime sold increased by nearly 4% to \$104.70 per ton (\$95.00 per short ton). The average value for dolomitic quicklime sold increased by more than 4% to \$117.80 per ton (\$106.80 per short ton). The average value of high-calcium hydrate increased by nearly 6% to \$129.80 per ton (\$117.80 per short ton), while the average value of dolomitic hydrate increased slightly to \$142.20 per ton (\$129.00 per short ton).

Foreign Trade

The United States exported and imported calcined dolomite (dolomitic lime), hydrated lime (slaked lime), hydraulic lime, and quicklime. Combined exports of lime were 231,000 t (254,000 short tons) valued at \$40.1 million. About 85% of exports went to Canada, with the most of the remaining exports going to Russia (7%) and Mexico (4%) (table 6).

Combined imports of lime were 512,000 t (564,000 short tons) valued at \$69.9 million, with more than 94% from Canada, 5% from Mexico, and 1% from other countries (table 7). Canada provided almost all imports of high-calcium and dolomitic quicklime and accounted for 99% of the total of each. Imports of hydrated lime came mostly from Canada (54%) and Mexico (44%).

No tariffs are placed on imports of hydraulic lime, quicklime, and slaked lime from countries with normal trade relations (NTR) with the United States. A 3% ad valorem tariff is placed on imports of calcined dolomite from NTR countries.

World Review

Lime is not a commodity that is traded internationally. Traditionally, lime has been a low-value bulk product that could not be shipped long distances and compete with lime produced locally. Most countries have limestone or dolomite deposits and, as a result, are able to manufacture lime for their own consumption. There may be some trade between countries on a regional basis where distances are not too great, such as in the European Union, or to supply lime products of quality not locally available.

With the exception of some industrialized nations, accurate lime production data for individual countries are difficult to obtain. Besides production by large commercial lime companies, lime is produced by small-scale manufacturers operating simple kilns to supply individual villages and by industries producing lime for internal consumption. These variations and the frequent confusion with limestone data make accurate collection of international lime data difficult and certainly incomplete. In some cases, lime sales data have been used to estimate country production figures. Beginning in 2006, major revisions were made to the annual estimates for China based on new information. Beginning in 2009, major revisions were made to annual estimates for India, based on steel production and other market assumptions (table 8).

The following is a sampling of some of the lime projects constructed in 2011 in various countries around the world.

Bulgaria.—Bulgaria's leading lime producer Ognyanovo K AD, a member of Plena Group LLC (Luxembourg), announced that its new kiln producing high-reactivity quicklime began production in January 2011. The new kiln was designed to produce up to 200 metric tons per day (t/d) of quicklime containing 94% CaO. In 2011, Ognyanovo K was the leading lime and limestone company in Bulgaria with annual sales of approximately 150,000 t of lime and more than 1 Mt of limestone. The company's network of customers extends throughout Bulgaria and into Greece, Macedonia, and Serbia. Ognyanovo K operated two lime and limestone operations in Bulgaria at Puklina and Ognyanovo and was installing another

new lime kiln, which was scheduled to start in early 2012 (Ognyanovo K AD, 2011; Plena Group LLC, 2011).

Israel.—Negev Industrial Minerals Ltd. (Omer) started production from its new Maerz Ofenbau AG parallel flow regenerative shaft kiln (PFR kiln) at its Mishor Totem plant. This type of kiln has two vertical shafts connected to each other by a crossover channel. This allows for calcination of the limestone feedstock in one shaft with the simultaneous preheating of the feedstock in the second shaft using the mixture of combustion gases and cooling air from the other shaft. The new kiln has a capacity of 300 t/d and can be fueled using either 100% natural gas, 100% heavy fuel oil, or a mixture of biogas and heavy fuel oil (Maerz Ofenbau AG, 2011a, p. 4).

Morocco.—Lafarge Calcinor Maroc S.A.S. (Casablanca) started operation of its new Maerz PFR kiln at its Tlad Loulad plant. Lafarge Calcinor Maroc is a joint venture of Lafarge S.A. (Paris, France) and the Calcinor Group (Spain). The new kiln was designed to produce about 250 t/d of quicklime using pulverized petroleum coke as fuel (Maerz Ofenbau AG, 2011b, p. 3).

Russia.—Lhoist Group (Ottignies-Louvain-la-Neuve, Belgium) and OAO TMK (Moscow) announced plans for a joint venture to construct a plant in the Sverdlovsk Region to produce lime and associated products. Lhoist is a leading lime producer with a large presence in Europe and North America. TMK is a leading producer of pipe for the oil and gas industry in Russia and worldwide. Limestone would be sourced from the Yuzhno-Mikhailovsky limestone deposit, and the project would provide lime and limestone for steel production needed for TMK's pipe production and for other industries in the region. Lhoist would hold a 70% stake in the joint venture and TMK the remaining 30%. No information on the size or capacity of the operation was released (Watts, 2011).

Saudi Arabia.—Saudi Sand Lime Bricks & Building Materials Co. (Riyadh) began lime production in 2011 from its new Maerz annular shaft kiln. The new kiln was added to the company's Riyadh plant, which produced soft-burned (highly reactive) lime for the steel and building industries and a medium-burned lime for use in sand lime bricks. The new kiln has a capacity of 200 t/d (Maerz Ofenbau AG, 2011c, p. 2–3).

Vietnam.—Linh Thanh Quang Binh Exploiting and Processing High Calcium Carbonate Powder Joint Stock Company (LTG Lime) installed a lime and PCC plant in Dong Hoi City. The combined plant was supplied by Terruzzi Fercalx Spa (Milan, Italy) and was designed as a continuous system to produce lime, recover carbon dioxide, and manufacture PCC (Industrial Minerals, 2010).

Outlook

The U.S. lime industry has recovered to a large degree from the 2008–09 recession, although production in 2011 was still about 2 Mt below the industry's peak year of 2006. The Nation's economic recovery has been slower than past recoveries, but according to the Federal Reserve Board, economic growth appeared poised to continue at a moderate pace. However, concerns remain about developments in Europe, U.S. fiscal policy, and the strength and sustainability of the economic recovery. In particular, the crisis in Europe has affected the U.S. economy by acting as a drag on U.S. exports, weighing on

business and consumer confidence, and adversely pressuring U.S. financial markets and institutions (Bernanke, 2012). Barring a major financial crisis in Europe, according to some analysts, the economy is expected to show more improvement in 2013. Other analysts are more negative, however, citing domestic economic and political problems combined with the financial troubles in Europe and a slowdown in China suggest that the United States is at risk of another recession. Market sectors such as chemical and industrial and metallurgical should track the economy. The traditional building market also depends on the health of the economy but will continue to lag until the housing market recovers. Lime sales as a whole should improve with improvements in the overall economy.

More problematic are the effects of certain fundamental changes in the FGD market. FGD, mostly from coal-burning powerplants, is the second leading end-use market for lime. With the recent boom in natural gas exploration, large increases in natural gas reserves, and natural gas prices falling, U.S. electric utilities have quickly shifted their fuel use. Utilities are aggressively shifting from the use of coal to natural gas, which has become substantially less expensive as supplies have increased. Natural gas also has the advantage of emitting fewer pollutants than coal and, as a result, makes it easier for the power industry to acquire the necessary air pollution permits to construct new powerplants or expand existing ones. Applying additional pressure on coal are recent environmental regulations enacted by the EPA that tightened limits on powerplant emissions of SO₂ and nitrogen dioxide (cross-state air pollution rule) and placed new limits on mercury emissions (mercury and air toxics standards). According to an Associated Press survey of powerplant operators conducted in late 2011, these new regulations alone were expected to result in the shutdown of at least 32, and possibly as many as 68, of the most polluting coal-fired powerplants in the country during the next 3 years as the rules go into effect. Coal had a 50% share of the electricity generation market 4 years ago, but it is forecast to fall below 40% in 2012—the lowest level since the Government began collecting these data in 1949. By the end of this decade, it is likely to be close to 30% (Fahey, 2012). The overall FGD market in 2011 was about 4 Mt, but this is expected to decrease in the future as a result of fuel switching at powerplants and the likely shutdown of some coal-fired powerplants for environmental reasons.

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TABLE 1
 SALIENT LIME STATISTICS^{1,2}

	2007	2008	2009	2010	2011
United States ³					
Number of plants ⁴	89	90	81	85	87
Sold or used by producers:					
Quicklime:					
High-calcium thousand metric tons	14,700	14,600 ^r	11,800	13,300 ^r	13,900
Dolomitic do.	2,710 ^r	2,630 ^r	1,830	2,570 ^r	2,690
Total do.	17,400	17,200	13,600	15,900	16,600
Hydrated lime:					
High-calcium do.	2,240	2,070	1,690	1,910	2,010
Dolomitic do.	357 ^r	358	261	239	230
Total do.	2,600 ^r	2,420	1,950	2,150	2,240
Dead-burned dolomite ⁵ do.	200	200	200	200	200
Grand total:					
Quantity do.	20,200	19,900	15,800	18,300	19,100
Value ⁶ thousand dollars	1,760,000	1,840,000	1,660,000	1,950,000 ^r	2,130,000
Average value dollars per metric ton	87.00 ^r	92.40	105.00 ^r	107.00 ^r	111.50
Lime sold by producers:					
Quicklime thousand metric tons	16,100	16,000	12,600	14,700	15,400
Hydrated lime do.	2,590	2,420	1,950	2,140	2,240
Total do.	18,700	18,400	14,500	16,900	17,700
Value thousand dollars	1,600,000	1,690,000	1,510,000	1,790,000 ^r	1,950,000
Lime used by producers thousand metric tons	1,540 ^r	1,470	1,260	1,380 ^r	1,430
Value thousand dollars	155,000	149,000	150,000 ^r	169,000 ^r	183,000
Exports: ⁷					
Quantity thousand metric tons	144	174	108	215	231
Value thousand dollars	24,800	27,100	18,500	36,200	40,100
Imports for consumption: ⁷					
Quantity thousand metric tons	375	307	422	445	512
Value thousand dollars	49,600	39,400	53,200	61,500	69,900
Consumption, apparent ⁸ thousand metric tons	20,400	20,000	16,100	18,500	19,400
World, production do.	302,000 ^r	312,000 ^r	297,000	313,000 ^r	331,000 ^c

^cEstimated. ^rRevised. do. Ditto.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²To convert metric tons to short tons, multiply metric tons by 1.102.

³Excludes regenerated lime; includes Puerto Rico.

⁴Includes most producer-owned hydrating plants not located at lime plants.

⁵Data are rounded to no more than one significant digit to avoid disclosing company proprietary data.

⁶Selling value, free on board plant.

⁷Source: U.S. Census Bureau.

⁸Defined as sold or used plus imports minus exports.

TABLE 2
LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY STATE^{1,2}

State	Plants ³	Hydrated (thousand metric tons) ⁴	Quicklime ⁵ (thousand metric tons) ⁴	Total (thousand metric tons) ⁴	Value (thousands)
2010:					
Alabama	6	153	2,000	2,150	\$239,000
Arizona, Colorado, Montana, Nevada, New Mexico, Utah, Wyoming	14	189	2,330	2,510	273,000 ^r
California, Idaho, Oregon, Washington	9	52	212	264	39,700
Indiana, Missouri	5	401	3,140	3,540	361,000
Iowa, Nebraska, South Dakota	3	(6)	354	354	35,700
Kentucky, Tennessee, West Virginia	6	112	2,490	2,600	235,000
Michigan	6	--	465	465	49,200
Ohio	5	79	1,530	1,610	189,000 ^r
Pennsylvania	4	179	926	1,110	145,000
Texas	5	553	730	1,280	136,000
Wisconsin	4	150	716	867 ^r	81,200
Other ⁷	18 ^r	236	1,270 ^r	1,510 ^r	172,000 ^r
Total	85	2,100	16,200	18,300	1,950,000 ^r
2011:					
Alabama	6	141	2,040	2,180	255,000
Arizona, Colorado, Montana, Nevada, Utah, Wyoming	14	193	2,480	2,670	304,000
California, Idaho, Oregon, Washington	9	57	213	270	43,700
Indiana, Missouri	5	428	3,150	3,580	373,000
Kentucky, Tennessee, West Virginia	7	115	2,690	2,800	262,000
Michigan	6	--	518	518	56,500
Ohio	6	81	1,650	1,730	208,000
Pennsylvania	4	178	976	1,150	156,000
Texas	5	600	745	1,350	148,000
Wisconsin	4	146	793	939	95,900
Other ⁸	21	302	1,610	1,920	226,000
Total	87	2,240	16,900	19,100	2,130,000

^rRevised. -- Zero.

¹Excludes regenerated lime.

²Data are rounded to no more than three significant digits; may not add to totals shown.

³Includes most producer-owned hydrating plants not located at lime plants.

⁴To convert metric tons to short tons, multiply metric tons by 1.102.

⁵Includes dead-burned dolomite.

⁶Withheld to avoid disclosing company proprietary data; included in "Quicklime."

⁷Includes Arkansas, Florida, Georgia, Louisiana, Massachusetts, Minnesota, North Dakota, Oklahoma, Puerto Rico, and Virginia.

⁸Includes Arkansas, Florida, Georgia, Iowa, Louisiana, Massachusetts, Minnesota, Nebraska, North Dakota, Oklahoma, Puerto Rico, South Dakota, and Virginia.

TABLE 3
LIME SOLD OR USED BY PRODUCERS IN THE UNITED STATES, BY USE^{1,2}

(Thousand metric tons³ and thousand dollars)

Use	2010		2011	
	Quantity ⁴	Value ^{r,5}	Quantity ⁴	Value ⁵
Chemical and industrial:				
Fertilizer, aglime and fertilizer	52	5,570	45	5,020
Glass	181	19,400	167	18,600
Paper and pulp	843	90,200	945	105,000
Precipitated calcium carbonate	1,010	108,000	905	101,000
Sugar refining	671	71,800	686	76,500
Other chemical and industrial ⁶	1,420	152,000	1,460	162,000
Total	4,170	447,000	4,200	469,000
Metallurgical:				
Steel and iron:				
Basic oxygen furnaces	2,430	260,000	2,560	286,000
Electric arc furnaces	2,670	286,000	3,010	335,000
Other steel and iron	212	22,700	263	29,300
Total	5,310	568,000	5,840	651,000
Nonferrous metallurgy ⁷	1,130	121,000	1,330	149,000
Total metallurgical	6,440	690,000	7,170	799,000
Construction:				
Asphalt	262 ^r	28,000	265	29,500
Building uses	230	24,600	211	23,500
Soil stabilization	1,020 ^r	109,000	1,010	112,000
Other construction	39	4,170	52	5,800
Total	1,550	166,000	1,540	171,000
Environmental:				
Flue gas desulfurization (FGD):				
Utility powerplants	3,520	376,000	3,650	407,000
Incinerators	227	24,300	212	23,600
Industrial boilers and other FGD	70	7,490	86	9,590
Total	3,820	408,000	3,950	440,000
Sludge treatment:				
Sewage	110	11,800	104	11,600
Other, industrial and hazardous	85	9,100	122	13,600
Total	195	20,900	227	25,200
Water treatment:				
Acid-mine drainage	90	9,630	120	13,400
Drinking water	911	97,500	913	102,000
Wastewater	649	69,500	530	59,100
Total	1,650	177,000	1,560	174,000
Other environmental	226	24,200	224	25,000
Total environmental	5,890	630,000	5,970	665,000
Refractories (dead-burned dolomite)	200 ⁸	22,600 ⁹	200 ⁸	25,600 ⁹
Grand total	18,300	1,950,000	19,100	2,130,000

^rRevised.

¹Excludes regenerated lime. Includes Puerto Rico.

²Data are rounded to no more than three significant digits; may not add to totals shown.

³To convert metric tons to short tons, multiply metric tons by 1.102.

⁴Quantity includes lime sold and used, where "used" denotes lime produced for internal company use for basic oxygen furnaces, magnesia, paper and pulp, precipitated calcium carbonate, refractories, and sugar refining.

⁵The U.S. Geological Survey does not collect value data by end use; the values shown are derived from average lime values.

⁶May include alkalis, calcium carbide and cyanamide, calcium hypochlorite, citric acid, food (animal or human), oil and grease, oil well drilling, petrochemicals, tanning, and other uses. Magnesia is included here to avoid disclosing proprietary data.

⁷Includes aluminum and bauxite, magnesium, ore concentration (copper and gold), and other nonferrous uses.

⁸Data are rounded to no more than one significant digit to avoid disclosing company proprietary data.

⁹Value was derived from an average lime value per metric ton rather than a specific average value per metric ton of dead-burned dolomite.

TABLE 4
HYDRATED LIME SOLD OR USED IN THE UNITED STATES, BY END USE^{1,2}

(Thousand metric tons³ and thousand dollars)

Use	2010		2011	
	Quantity ⁴	Value ⁵	Quantity ⁴	Value ⁵
Chemical and industrial	539	67,200	582	83,000
Construction:				
Asphalt	239 ^r	29,800 ^r	236	30,900
Building uses	220	27,400	200	26,200
Soil stabilization	401 ^r	50,000 ^r	423	55,400
Other construction	10	1,250	14	1,830
Total	869 ^r	108,000	874	114,000
Environmental:				
Flue gas desulfurization (FGD):				
Utility powerplants	157	19,600	173	22,600
Incinerators	31	3,870 ^r	31	4,060
Industrial boilers and other FGD	24 ^r	2,990 ^r	31	4,060
Total	212 ^r	26,400 ^r	235	30,800
Sludge treatment:				
Sewage	16	2,000 ^r	19	2,490
Other sludge treatment	30	3,740	30	3,930
Total	46	5,740 ^r	49	6,410
Water treatment:				
Acid-mine drainage	45	5,610	68	8,900
Drinking water	140	17,500	149	19,500
Wastewater	186	23,200	179	23,400
Total	371	46,300 ^r	396	51,800
Other environmental	72	8,980 ^r	64	8,380
Metallurgy	43	5,360	41	5,370
Grand total	2,150	268,000	2,240	300,000

^rRevised.

¹Excludes regenerated lime. Includes Puerto Rico.

²Data are rounded to no more than three significant digits; may not add to totals shown.

³To convert metric tons to short tons, multiply metric tons by 1.102.

⁴Quantity includes hydrated lime sold and used, where "used" denotes lime produced for internal company use in building, chemical and industrial, and metallurgical sectors.

⁵The U.S. Geological Survey does not collect value data by end use; the values shown are derived from an average value per metric ton of hydrated lime.

TABLE 5
LIME PRICES¹

Type	2010		2011	
	Dollars per metric ton	Dollars per short ton ²	Dollars per metric ton	Dollars per short ton ²
Sold and used:				
Quicklime	103.70 ^r	94.10 ^r	107.90	97.90
Hydrate	124.70 ^r	113.10 ^r	130.90	118.70
Average all types ³	107.00 ^r	97.10 ^r	111.50	101.10
Sold:				
High-calcium quicklime	100.80 ^r	91.40 ^r	104.70	95.00
Dolomitic quicklime	113.00 ^r	102.50 ^r	117.80	106.80
Average quicklime	102.70 ^r	93.20 ^r	106.80	96.90
High-calcium hydrate	122.80 ^r	111.40 ^r	129.80	117.80
Dolomitic hydrate	139.30	126.40 ^r	142.20	129.00
Average hydrate	124.60	113.00	131.10	118.90
Average all types ³	105.80 ^r	96.00 ^r	110.10	99.90

^rRevised.

¹Average value per ton, on a free-on-board-plant basis, including cost of containers.

²Unit values in metric and short tons were rounded independently.

³Includes dead-burned dolomite.

TABLE 6
U.S. EXPORTS OF LIME, BY TYPE¹

(Metric tons and dollars)

Type	2010		2011	
	Quantity ²	Value ³	Quantity ²	Value ³
Calcined dolomite:				
Canada	57,300	10,000,000	51,400	9,530,000
Colombia	317	108,000	57	50,900
Germany	1,080	295,000	3,140	649,000
Mexico	34	7,570	216	52,300
Other	296	136,000	1,250	489,000
Total	59,100	10,600,000	56,100	10,800,000
Hydraulic lime:				
Bahamas, The	123	30,100	141	26,600
Canada	3,640	757,000	7,340	1,860,000
Vietnam	--	--	161	29,000
Other	165	411,000	178	124,000
Total	3,930	1,200,000	7,820	2,030,000
Quicklime:				
Canada	109,000	14,900,000	121,000	16,800,000
Costa Rica	662	212,000	136	42,600
Mexico	8,490	982,000	8,870	976,000
Russia	13,400	3,000,000	15,300	4,590,000
Other	675	805,000	2,140	933,000
Total	132,000	19,900,000	148,000	23,300,000
Slaked lime, hydrate:				
Angola	884	505,000	371	152,000
Canada	18,300	3,550,000	16,300	3,070,000
Nigeria	304	127,000	389	118,000
Other	373	356,000	1,930	665,000
Total	19,900	4,540,000	19,000	4,000,000
Grand total	215,000	36,200,000	231,000	40,100,000

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²To convert metric tons to short tons, multiply metric tons by 1.102.

³Declared free alongside ship valuation.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF LIME, BY TYPE¹

(Metric tons and dollars)

Type	2010		2011	
	Quantity ²	Value ³	Quantity ²	Value ³
Calcined dolomite:				
Canada	29,600	4,580,000	67,900	10,500,000
Mexico	13,200	4,470,000	1	5,330
Other	409	292,000	203	184,000
Total	43,200	9,340,000	68,100	10,700,000
Hydraulic lime:				
Canada	31	3,770	104	13,800
France	240	127,000	71	39,000
Other	43	23,900	--	--
Total	314	155,000	175	52,900
Quicklime:				
Canada	340,000	42,400,000	386,000	49,400,000
Colombia	2,010	255,000	--	--
Mexico	4,680	569,000	2,040	390,000
Other	873	482,000	744	474,000
Total	348,000	43,700,000	388,000	50,300,000
Slaked lime, hydrate:				
Canada	31,500	4,250,000	29,500	3,930,000
Mexico	21,700	3,410,000	24,200	4,030,000
Other	909	728,000	1,470	947,000
Total	54,000	8,390,000	55,100	8,910,000
Grand total	445,000	61,500,000	512,000	69,900,000

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²To convert metric tons to short tons, multiply metric tons by 1.102.

³Declared cost, insurance, and freight valuation.

Source: U.S. Census Bureau.

TABLE 8
QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY^{1,2}

(Thousand metric tons)

Country ³	2007	2008	2009	2010	2011 ^c
Australia ^c	1,600	2,200	2,000	2,000	2,000
Austria	491	612	507	517 ^r	520
Belgium ^{c,4}	2,400	2,300	2,000	2,000	2,000
Bosnia and Herzegovina	237	216	281	339 ^r	340
Brazil ^c	7,393 ⁵	7,400	7,000 ^r	7,400 ^r	7,700
Bulgaria ⁴	1,443	1,422	950	1,309 ^r	1,300
Canada	2,134	2,069	1,601	1,913 ^r	1,959 ^{p,5}
Chile ^c	840	820	790	790 ^r	800
China ^c	170,000	180,000	185,000	190,000	200,000
Croatia ^{c,4}	572 ⁵	541	415	415	415
Czech Republic	1,277	1,150	1,000	1,100 ^c	1,000
Egypt ^c	1,000 ⁵	1,000 ⁵	800	800	800
Finland ^c	517 ⁵	482 ⁵	500	475	475
France ^{c,4}	4,000	4,000	3,500	3,800 ^r	3,900
Germany	7,218	7,313	5,945 ^r	6,856 ^r	7,000
Hungary ^c	500	500	500	500	500
India ^c	12,000	13,000	13,000	14,000	15,000
Iran ^c	2,600	2,700	2,600 ^r	2,700	2,800
Israel	282	481	429	658 ^r	660
Italy ^{c,6}	6,000	5,900 ^r	5,400 ^r	6,000	6,200
Jamaica	277	313	300	300 ^e	300
Japan, quicklime only	9,359	9,528	6,746	8,547 ^r	9,000
Kazakhstan	1,023	906	798	881 ^r	958 ⁵
Korea, Republic of ^c	3,900	4,000	NA ^r	NA ^r	3,900
Malaysia ^c	1,300	900	800	900	1,000
Mexico ^{c,4}	6,200	6,000	6,200 ^r	6,400 ^r	6,400
Peru ^c	216 ^r	216 ^r	216 ^r	216	216
Poland	2,143	1,952	1,716	1,799 ^r	1,800
Romania ^c	2,000	2,000	1,600	2,000	2,000
Russia ^c	8,200	8,200	7,000	8,000	8,200
Saudi Arabia ^c	400	400	400	400	400
Serbia	320	292	251	239 ^r	240
Slovakia	1,123	1,082	867	900	900
Slovenia ^c	1,500	1,500	1,500	1,500	1,200
South Africa, burnt lime sales	1,599	1,593	1,375	1,286	1,400
Spain ^{c,4}	2,000	2,000	2,000	2,200	2,100
Sweden ^c	780	750	600	700	700
Taiwan ^c	470	450	450	450	450
Thailand ^c	800	800	750	750	750
Tunisia	395	369	366	370	350
Turkey ^{c,4}	4,000	4,000	3,800	4,300	4,500
Ukraine	5,688	5,128	4,101	4,220	4,253 ⁵
United Kingdom ^c	2,000	1,500	1,500	1,500	1,500
United States, including Puerto Rico	20,200	19,900	15,800	18,300	19,100 ⁵
Venezuela ^c	400	400	400	400	400
Vietnam	1,438	1,619	1,584 ^r	1,454 ^r	1,600
Zambia ^c	165	135	134 ^r	170 ^r	180
Other ^c	1,630 ^r	1,760 ^r	1,650 ^r	1,650 ^r	1,620
Total	302,000 ^r	312,000 ^r	297,000	313,000 ^r	331,000

^cEstimated. ^pPreliminary. ^rRevised. NA Not available.

¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through April 12, 2012.

³In addition to the countries listed, Argentina, Chad, Iraq, Nigeria, Pakistan, Syria, and several other nations produce lime, but output data are not reported; available general information is inadequate to formulate reliable estimates of output levels.

⁴Production estimate based on sales only; data may be incomplete.

TABLE 8—Continued

QUICKLIME AND HYDRATED LIME, INCLUDING DEAD-BURNED DOLOMITE: WORLD PRODUCTION, BY COUNTRY^{1,2}

⁵Reported figure.

⁶Includes hydraulic lime.