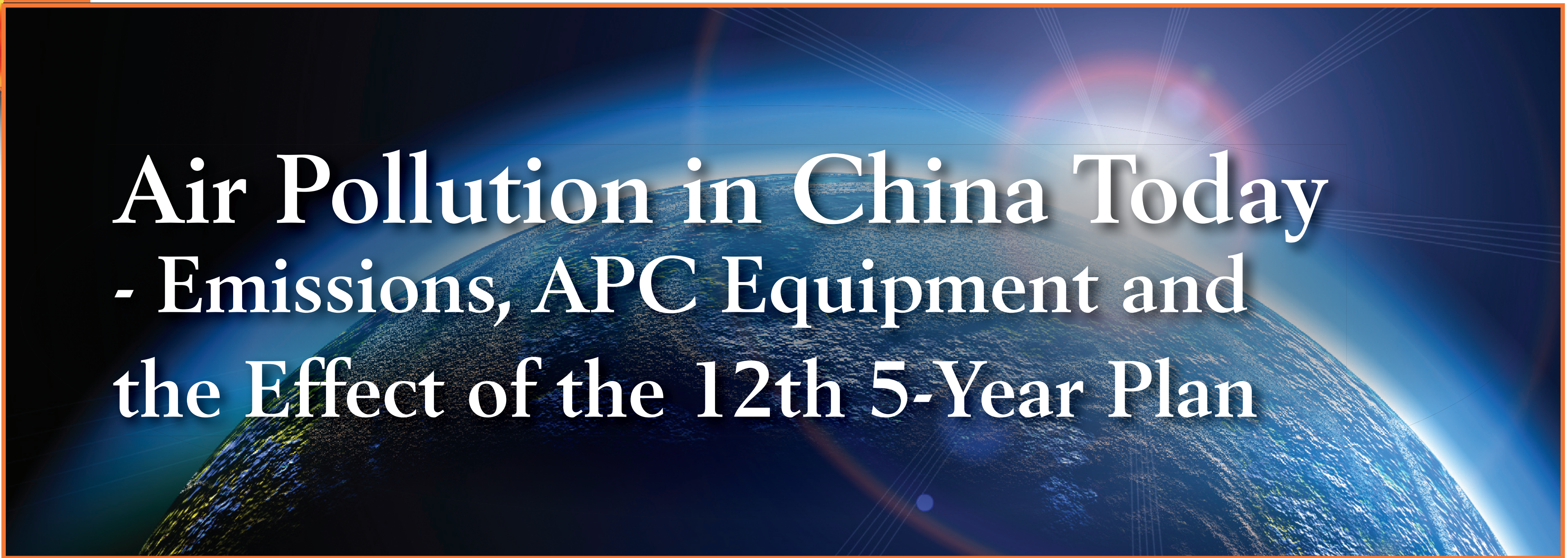

Air Pollution in China Today - Emissions, APC Equipment and the Effect of the 12th 5-Year Plan

Air pollution control (APC) has been prominently included as one of the most important targets for the Chinese government in its 12th 5-year plan. In first half of 2013, as Northern China experienced some of the heaviest polluted days and the Beijing-Tianjin-Hebei area was the worst among the 74 cities whose air quality Ministry of Environmental Protection (MEP) monitors, a series of government action plans and targets for key province-level regions was promulgated. These new regulations were unveiled in September 2013. As of the end of 2013, the mid-point of the current five-year plan, GCiS offers a review of how China has tackled its air pollution problems and how this initiative will roll forward from this point. As coal will continue as the main source of energy in China, fighting air pollution will remain one of the most important tasks for the Chinese government. Industrial sectors continue to have a significant role in the air pollution reduction as focus will gradually move away from the power industry towards metallurgy and cement industries.

> *"Fundamentally, if energy generation continues to rely heavily on coal combustion and China's annual GDP growth remains well above 7% as seen in the past years, China will undoubtedly continue to face this pollution problem in the years to come."*

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Industrial Sectors – The Main Source of Air Pollution

To date China has developed without recognising, accounting for, or seriously regulating industrial pollution. Coal provides the vast majority of electricity and heating and is the primary source of air pollution in China. Areas with heavy industrial concentrations consequently suffer from serious and systemic air pollution.

Figure 1 below illustrates the situation clearly using statistics from the Ministry of Environmental Protection (MEP). Even though there is good reason to suspect that MEP data understates the problem, it provides a rough idea of China's overall pollution conditions. For comparison, we have contrasted China's emissions with key SO_2 and NO_x data for the United States as reported by the US Environmental Protection Agency. SO_2 emissions for 2012 were 6 million tons, while NO_x emissions were 11 million tons. This compares with China's 21 million and 23 million tons respectively.

As is clearly illustrated, industrial sources are the main origin of the air pollution in China.

Figure 1: Major Air Pollutant Sources in China (million tons)

	Industrial	Social	Auto	Total
Dust and Smoke (2011)	11.0 86%	1.1 9%	0.6 5%	12.8
SO_2 (2012)	19.1 90%	2.1 10%	- -	21.2
NO_x (2012)	16.6 71%	0.4 0.2%	6.4 27%	23.4

Source: Ministry of Environmental Protection

Industrial Particulate Matter Control

Dust and smoke emission is mostly composed of particulate matter and are one of the primary sources of both PM 2.5 (particles smaller than 2.5 micrometers) and PM 10 (particles smaller than 10 micrometers) levels of tracked air pollution. In the industrial sector, three types of dust and smoke control equipments are commonly used in China: Electrostatic Precipitators (ESP), Compact Electrostatic Baghouse Precipitators (COEBP), and Fabric Dust Collectors (FDC). FDC have better performance in removing smaller particulate matters than ESP; however, they are also more expensive than ESP. COEBP is usually an upgrade solution for ESP and improves on the efficiency on small particulate capture.

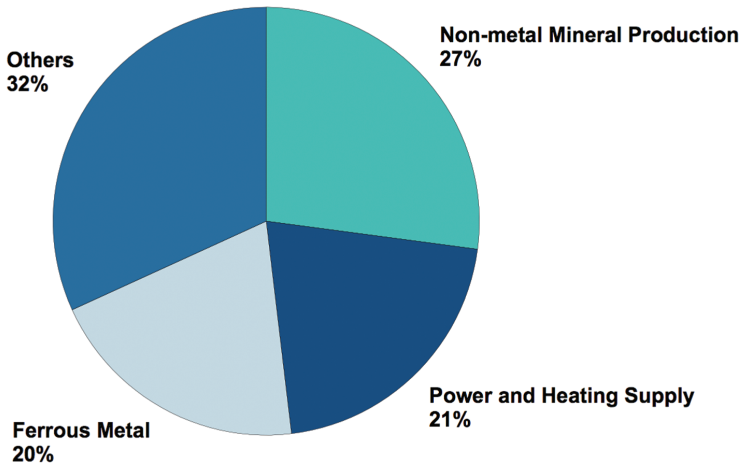
According to Figure 2, non-metal mineral production (mainly cement, ceramics and other building materials), power generation and ferrous metal production (mainly steel) account for approximately 68% of total dust emissions in the industrial sector.

Dust control installations in the Power and Cement industries began as early as 2003. The Power industry adopted ESP due to its local content, low cost, and ease of installation. The result was high growth rates for ESP installations prior to 2011. Emission standards for the Power industry were tightened in 2011, leading to a surge in ESP upgrades. ESP effectiveness is impacted by equipment condition and the particulate content within the flue gas. The result is a progressive reduction in effectiveness over time. Addressing this problem leads to upgrades COEBP technologies in existing power plants. New plants, due to better profitability and tightened regulations are frequently, but not universally, installing the more expensive but more efficient FDC technology from the outset.

China has been struggling for some time to reduce the excess capacity that plagues the steel and cement industries, and this remains the first emphasis for reducing air pollution from these industries. While some old vertical cement kilns have previously installed ESP equipment, new cement plants using dry process manufacture tend to install FDC. Local governments are taking a dual, and sometimes contradictory role in managing this process. On one hand, local governments tend to protect these enterprises due to tax revenue, employment and associated reasons, while at the same time pressing them through inspections, fines and even (periodic, temporary) shutdowns to upgrade. This is becoming increasingly urgent in the industrial north where most of the major polluters are located and the pollution problems most acute. Thus these sectors, while not enjoying policy or subsidy support due to the need to wring out excess capacity, are expected to see further demand growth for APC equipment.

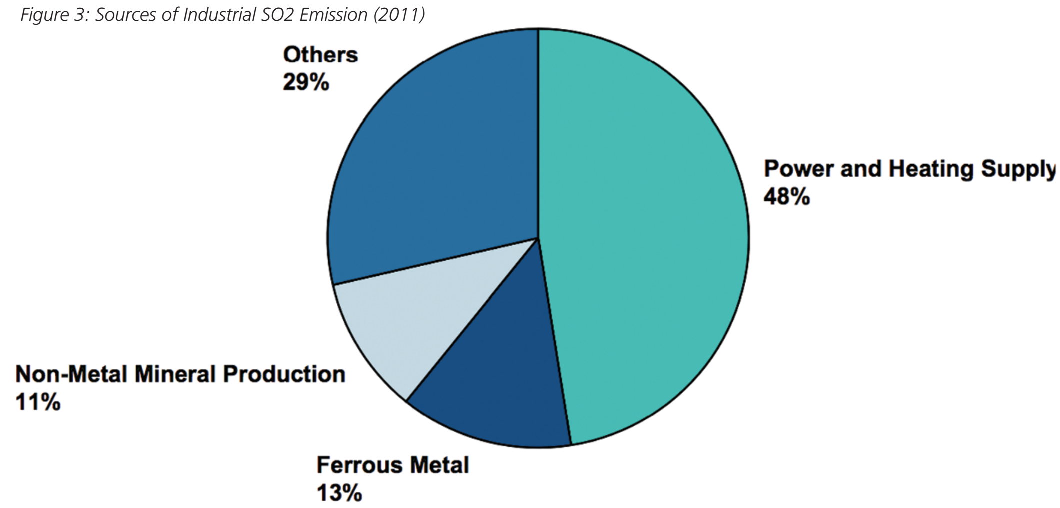
Overall, GCiS research shows that the growth of ESP is expected to slow down substantially due to technology upgrade and replacement, while COEBP and FDC will likely see steady increases in the coming years as they continue to gain recognition in China and as domestic material filtering technology advances to produce even better quality products.

Figure 2: Sources of Industrial Dust Emissions (2011)



Source: Ministry of Environmental Protection

Figure 3: Sources of Industrial SO2 Emission (2011)



Source: Ministry of Environmental Protection

Desulphurisation

As shown in Figure 3, coal fired power plants and ferrous metal are the largest contributors to both SO_2 emissions in China by a substantial margin. Non-metal mineral production accounts for another 11% of the SO_2 emission.

In 2011, China's central government outlined several emission reduction guidelines for different industrial sectors. In order to reach the target of reducing SO_2 emissions by 8% across China, the Chinese industrial sector has to achieve a minimum 10% reduction in SO_2, among which steel industry has the highest SO_2 reduction target of 27%.

Generally, technology adopted for desulphurisation in China is wet scrubbers with limestone and plaster or circulating fluidised-bed technologies. Some power plants along the coast have adopted a seawater process and a few use ammonia or other techniques.

Figure 4: 12th Five-Year Plan SO_2 Emission Reduction Guidelines

	2010 Emissions (Kilotons)	2015 Planned Emissions (Kilotons)	Reduction from 2010 Levels (%)
Overall China	22,678	20,864	8%
Overall Industrial Sector	20,730	18,660	10%
- Coal Fired Power Plants	9,560	8,000	16%
- Steel	2,480	1,800	27%

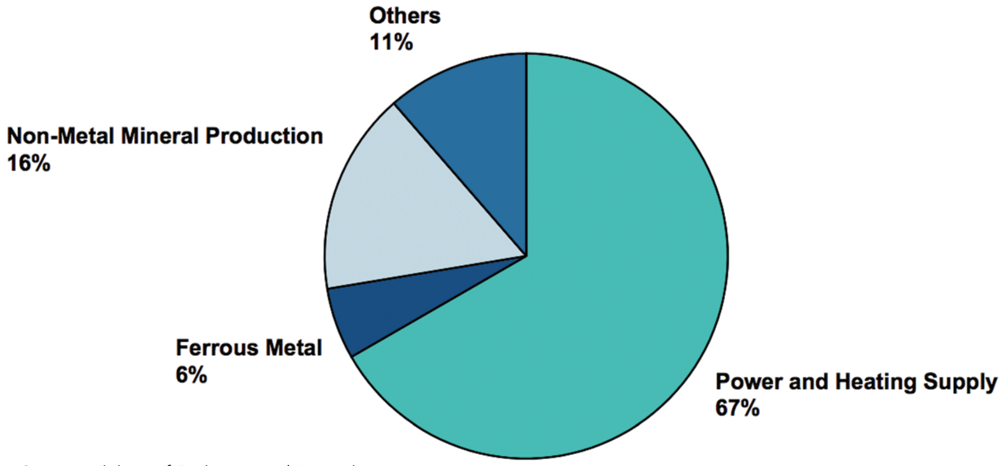
Source: Ministry of Environmental Protection, GCiS

As early as 2003, the government published emission standards for SO_2 for power plants and the emission standard was further strengthened in 2011. Coal fired power plants have led the way in SO_2 emission reduction for many reasons. Power generation is one of the industries that received early regulation, being the largest consumer of coal in China. Subsidies such as higher feed-in-tariffs have given these plants incentive for installation of desulphurisation equipment. As many engineering companies offering products and services are subsidiaries within large power groups, costs and pricing are not transparent. The installation of desulphurisation equipment has been rising since 2003, with growth peaking in 2011 – the recent decline is because most existing and newly built power plants have already installed the required equipment. By the end of 2012, installed capacity with desulphurisation equipment has grown to around 90% of the total coal-fired power plant installed capacity.

The steel industry is the second largest producer of sulphur dioxide, accounting for 13% of total annual emissions. As a result, the 12th five-year plan has outlined a series of measures aimed at controlling and reducing sulphur dioxide emissions in the steel industry by 27%. It is hoped that this can be achieved by specifically targeting the reduction of SO_2 in flue gas by mandating the installation of desulphurisation equipment for all new and existing sintering plants. However, unlike coal-fired power plants, steel mills currently do not receive subsidies from the government on their SO_2 reductions. In addition, the unclear outlook for real estate and infrastructure construction, coupled with massive overcapacity in China has resulted in steel mills operating on very thin profit. Installation of air pollution control equipment would further erode their profit. If these premises change, GCiS research reveals that with a current installation rate of only 30%, the project pipeline for these systems is expected to remain strong for the next few years.

Even though non-metal mineral production account for 11% of the SO_2 emission, focus has seldom been directed towards this sector. In late 2012, kilns for construction ceramics larger than 700,000 m² with fuel containing more than 0.5% sulphur and float glass production lines are required to install desulphurisation equipment or use alternative green energy as fuel (natural gas). As no specific reduction target has been appointed to this industry, which often means less supervision, GCiS believes that these regulations are unlikely to be fully enforced. Further, construction material factories have been negatively impacted from both weak domestic demand and weaker exports; therefore there is less financial motivation for them to take action. With environmental protection emphasis gradually shifting from the Power industry to other industrial sectors, this might become an area of opportunity in the near future.

Figure 5: Sources of Industrial NO_x Emission (2011)



Source: Ministry of Environmental Protection

Denitrification

As shown in Figure 5, coal fired power plants are the largest contributor to NO_x emissions in China. Trailing closely behind thermal power generation industry, the cement industry is the second largest source of NO_x emissions, accounting for another 16%.

In order to reach the target of reducing NO_x emissions by 10% across China, Chinese industry has to achieve a minimum 15% reduction in NO_x by 2015 and coal fired power plants face the highest NO_x reduction target of 29%.

To cope with the emission reduction targets, two types of equipment are essential to helping heavy industry reduce its and NO_x emission levels: denitrification equipment (De- NO_x - both selective catalytic and non-catalytic reduction processes are adopted in China) and Lo- NO_x burners.

Specific targets and action plans for coal fired power plants to tighten NO_x emission control were introduced by the end of 2012. All coal fired power plants with unit capacity of 300 MW or over are required to install denitrification systems. Target also sets completion of De- NO_x equipment installation for power plants to reach a combined installation of 400 GW (as half of total thermal power plant generating capacity) and Lo- NO_x burners for power plants to reach a total installed capacity of 70GW. These targets represent half of total thermal power plant generating capacity in China. Regional regulations have also been tightened, as coal fired power plants with capacity over 200 MW in all provincial cities in Eastern China are required to install De- NO_x filters. With subsidies on feed-in-tariff, these policies have resulted in rapid growth of the APC market in 2012, and according to recent GCiS research, the market for denitrification equipment has grown 25%. As of EoY 2012, coal fired power plants with De- NO_x installed accounted for around 27% of the total installed capacity. This is still far from the target levels, which also implies that large orders from coal fired power plants will continue to be placed in the next few years.

Figure 6: 12th Five-Year Plan NO_x Emission Reduction Guidelines

	2010 Emissions (Kilotons)	2015 Planned Emissions (Kilotons)	Reduction from 2010 Levels (%)
Overall China	22,736	20,462	10%
Overall Industrial Sector	16,370	13,910	15%
- Coal Fired Power Plants	10,550	7,500	29%
- Cement	1,700	1,500	12%

Source: Ministry of Environmental Protection, GCiS

As the second largest NO_x emission source, the situation in the Cement industry is completely different from the Power industry as there is no government financial support. All cement kilns for dry processing are required to install Lo- NO_x burners and all newly constructed cement kilns are required to install De- NO_x filters with an efficiency of over 60%. The vast majority of non-specialty cement production facilities are not willing to install such without subsidies. Many cement plants operators have yet to install or make the necessary upgrades to their exhaust gas scrubbers, and many installed systems only meet the minimum emission standard and remain as showcases. Note that the concentration standard of NO_x in cement flue gas has not been set high and is much higher than in the Power industry. GCiS expects NO_x emission in this sector to remain at a high level until financial support and stricter emission standards are introduced.

Denitrification in the steel industry is largely being neglected at the moment as it is not a main contributor to NO_x emission. Even though all newly built sinter plants for steel mills are required to install denitrification systems, GCiS have not seen significant activity in this sector.

Going Forward

GCiS does not expect China to face significant problems in meeting its SO_2 emission targets by 2015 as long as it does not deviate from its current pollution reduction plans. A series of pollution emission standards regarding steel industries published in 2012 have shown a shift in focus from power industry to steel industry and this trend is likely to become more prominent in the coming years. According to recent research by GCiS on China's APC market, the fastest growing product segment is De- NO_x and Lo- NO_x, as many end-users in the cement industry and power plants rush to install the appropriate equipment in order to meet the national standards. Local governments are also increasingly exerting pressure on these factories to reduce their pollution, and it has been noted that local governments in many provinces will not allow cement factories to operate until they install De- NO_x equipment.

The regional focus on air pollution control is also shifting towards the more heavily polluted northern regions. In the first half of 2013, the number of days that reached the minimum air quality standards in the Beijing-Tianjin-Hebei area was only 31%, which is significantly worse than Yangtze River Delta

and Pearl River Delta Regions. The major pollutants are PM 2.5, PM 10 and Ozone. A comprehensive plan to tackle air pollution was released in September 2013 with the principal aim of cutting down levels of PM 2.5 in major city clusters around Beijing, Shanghai and Guangzhou by 25%, 20% and 15% respectively. Although Beijing has the highest reduction target to limit its yearly average of PM 2.5 to around 60mg/m^3, it is still considered well above the national standard of 35 mg/m^3 and the safe limit of 10 mg/m^3 set by the World Health Organization. To achieve this, we can expect to see a combination of decreasing reliance on coal burning and switching to cleaner energy, while at the same time see the shutdown of inefficient small industrial factories and further upgrade and installation of air pollution control equipments in larger factories.

As air pollution control is largely driven by policies and government targets and updated standards on air quality measurements. A new set of air quality standards published in March 2012 has added PM 2.5 and ozone into its list of targeted pollutants, and PM 10 and NO_x target concentrations have also been lowered; these standards are due to take effect in 2016. These new targets will not only require major industries to install APC equipment but also require them to maintain their equipment with a minimum degree of efficiency. In the near future, we can expect to see an increase in upgrades of ESP to FDC or COEBP due to their enhanced PM 2.5 filtering capabilities. Furthermore, there is currently very limited emphasis placed on carbon monoxide, lead and ozone reductions, with no detailed data and specific targets set for 2015, though this is likely to change in the next five years.

Even though air pollution remains to be one of the biggest problems facing China today, there has been positive progress in this battle as a result of both actions taken in the industrial sectors and policy incentives laid out by the government. Fundamentally if energy generation continues to rely heavily on coal combustion and China's annual GDP growth remains well above 7% as seen in the past years, China will undoubtedly continue to face this pollution problem in the years to come. However this change is not going to happen over a short period of time and therefore the main mechanism for controlling air pollution in China in the near future will remain progressively stricter policies in the industrial sectors.

About GCiS China Strategic Research

GCiS (www.GCiS.com.cn) is a China-based market research and advisory firm focused on business to business markets. Since 1997, GCiS has been working with leading multinationals in sectors ranging from technology to industrial markets, medical, chemicals, resources, building and constructions and a few others.