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China's ENVIRONMENT

Big issues, accelerating effort, ample opportunities

Unprecedented growth has led to record levels of pollution in China's air, water and soil. Heavy metal contamination affects 12mn tons of grain in China every year, enough to feed 24mn people, equal to the population of Australia. With 60% of the country's groundwater unfit for human consumption, calls to fight pollution have grown louder across China. All these factors are combining to accelerate China's environmental initiatives, resulting in unprecedented government spending and ample investment opportunities.

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This report is a modified version of China's environment: Big issues, accelerating effort, ample opportunities, originally published on July 13, 2015.

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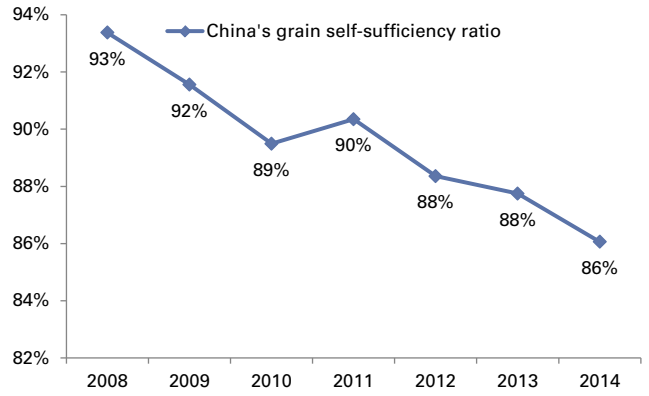
The prices in this report are based on the July 10, 2015 market close unless indicated otherwise.

Executive summary – The start of China's cleanup era

Why now and how big is the opportunity? Pg. 7

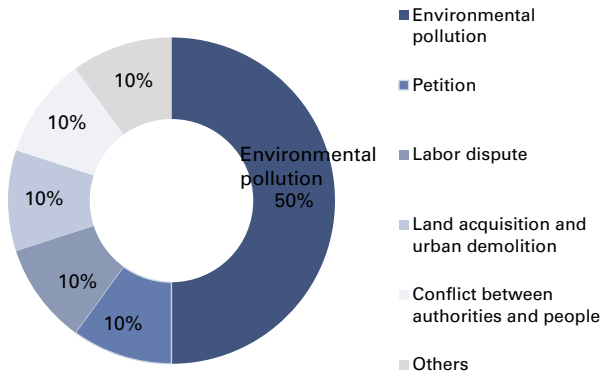
China's falling food supply sufficiency and the release of pollution survey data have helped spur rising concerns about pollution among policymakers and the wider population. The increased government regulation of relevant sectors and the inclusion of environmental metrics in local government performance assessments will also add impetus to the drive. Lastly, the opportunity to co-invest with the government should attract significant levels of private capital.

Exhibit 1: Pollution is impacting China's food security…



Source: NBS, CEIC, Goldman Sachs Global Investment Research.

Exhibit 2: …and a key social concern
Causes of mass disturbances (>10,000 people) in China

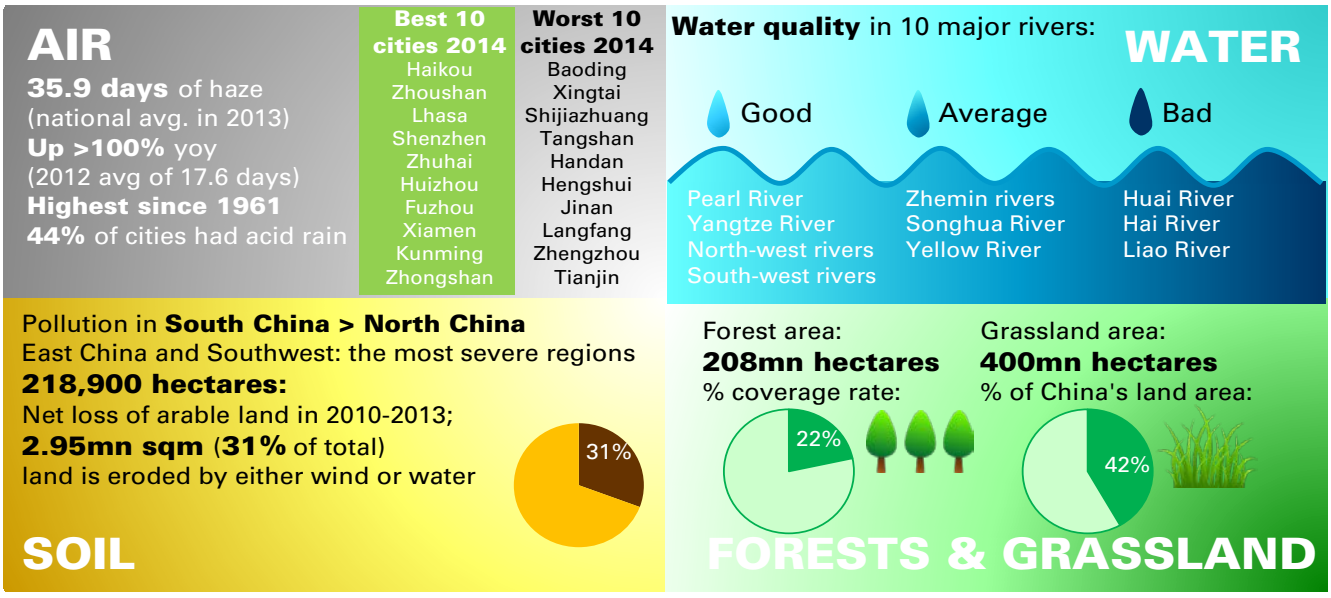


Source: Beijing News, Report on the Development of China's Rule of Law (2014).

Pollution in China – a primer Pg. 23

China's resource-heavy growth model has generated disproportionally more pollution compared to its contribution to global output. Air pollution attracts the most attention, but soil contamination (solid waste) is the most pressing environmental problem China faces.

Exhibit 3: China's pollution is accelerating – smoky air, toxic soil and contaminated water



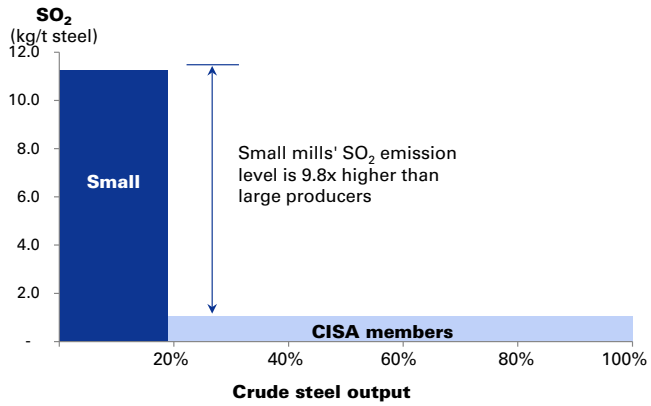
Note: Data as of 2014 unless otherwise stated.

Source: National Soil Pollution Survey, Ministry of Environmental Protection.

Policy solutions – regulating pollution away Pg. 34

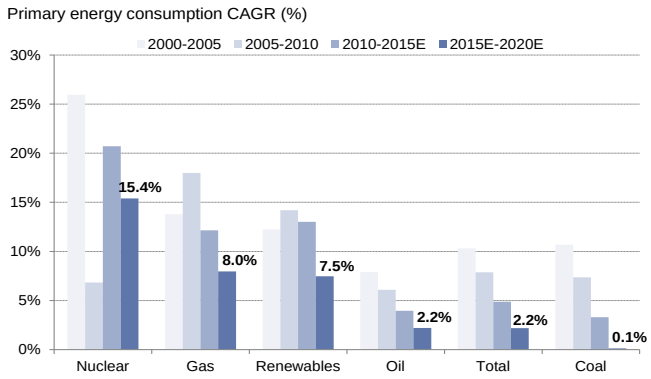
There are three key ways to combat pollution: 1) eliminating pollution at its source; 2) lowering emissions per unit of output; and 3) increasing the contribution of clean energy.

Exhibit 4: Shutting down small mills would reduce steel output by 20% but sulfur dioxide (SO_2) emissions by 72%
SO_2 emissions vs. steel output of small mills and CISA members (2013)



Source: MEP, CISA.

Exhibit 5: Nuclear is set to be China's fastest-growing primary energy source
Primary energy consumption CAGR (%), 5-year periods over 2000-2020E, China

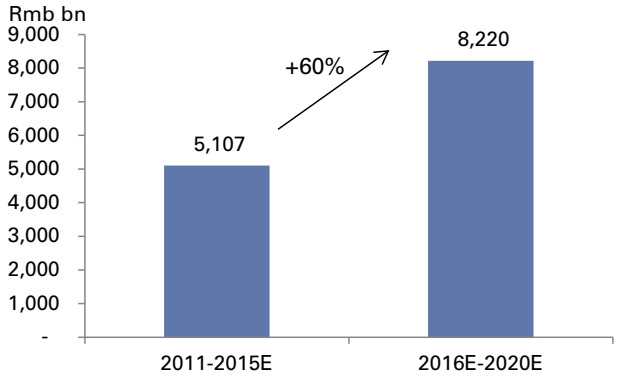


Source: BP Statistical Review, CEC, National Bureau of Statistics (NBS), NEA, Goldman Sachs Global Investment Research.

Monetization – charging pollution away Pg. 41

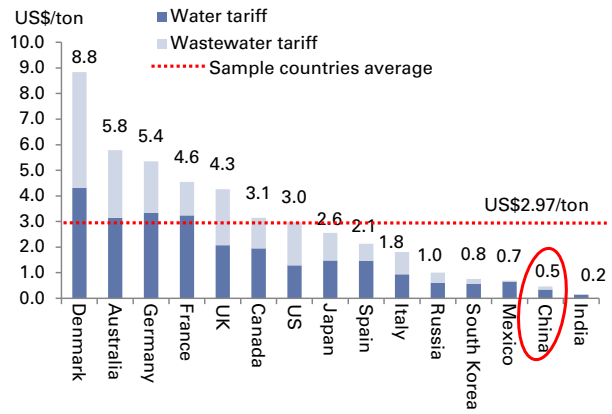
China's water tariffs are among the lowest in the world, and we see scope for inflection from their low base. Higher water tariffs should have a major long-term impact on relevant sectors in terms of capacity, costs, competition, profitability and return outlook. Key beneficiaries will likely include leading players in commodities, agriculture, clean energy, autos and catalytic materials.

Exhibit 6: We expect China's environmental investment to increase 60% in 2016-2020E from 2011-2015E



Source: MEP, Goldman Sachs Global Investment Research.

Exhibit 7: China's water tariffs are much lower than those of developed countries (2011)



Source: Global Water Intelligence (GWI), 2011 survey.

Further lessons – policy, investments, and more Pg. 52

Current policy landscape. What has the rest of the world done? China's current investment vs. the world. Beijing – a case study.

China's environment by the numbers

LARGEST GROWTH CONTRIBUTOR / WORST POLLUTER

15% OUTPUT VS. **44%-61%** INPUT / **10BN** TONS CO_2

China contributed 15% of global output in 2013, while it consumed 44%-61% of the word's copper, coal, steel, aluminum and cement. China emitted 10bn tons of CO_2 in 2013, greater than that of the US (5.35bn tons) and the EU (3.5bn tons) combined. (Page 24)

"APEC BLUE" TEMPORARY

16 CITIES **/ 10%**

Out of the 161 closely monitored cities, only 16 cities reached the national standards of urban air quality, with a pass rate of 10% in 2014. (Page 27)

WATER POLLUTION SEVERE

60% OF GROUNDWATER UNFIT FOR HUMAN CONSUMPTION

60% of groundwater in China is unfit for human consumption. About 50% of China's major environmental pollution-related social unrest is water-related. (Pages 28 and 29)

NO OFFICIAL STATISTICS ON SOIL POLLUTION UNTIL 2014

LAND EXCEEDS POLLUTION LIMIT > **900X** HONG KONG'S LAND AREA

16% of China's surveyed soil exceeds the national pollution standards, including 19% of arable land (2014). Among the 6.3mn sq. km of land surveyed, 1mn sq. km was polluted beyond the national limit, which is 900 times the land size of Hong Kong. (Pages 29 and 30)

RISING SOCIAL PRESSURE

POLLUTION-RELATED SOCIAL INCIDENTS **50%**

The persistent focus on growth has literally made pollution an unavoidable byproduct of economic growth. Pollution-related mass social incidents accounted for 50% of China 2013 total social incidents, becoming the top factor behind social instability. (Page 3)

SOIL POLLUTION & FOOD SAFETY CONCERNS

CONATMINATED GRAINS CAN FEED **24MN** PEOPLE
(> POPULATION OF AUSTRALIA 23.8MN)

According to a survey released in Apr 2014, 19% of arable land was contaminated with heavy metals, and 12mt of grains are contaminated by heavy metals each year. Assuming annual consumption of 500kg of grain per capita, this is enough grain to feed 24mn people, the population of Australia. In 2013, the discovery of rice tainted with cadmium in Guangdong and Hunan triggered panic buying of Thai rice. (Page 9)

FOOD SECURITY A REAL NATIONAL CONCERN

CHINA'S IMPORTED GRAINS WAS **17%** OF DOMESTIC OUTPUT (2014)

China has already become a major food importer, especially for grain. China's grain imports more than doubled from 41mt in 2008 to 100mt in 2014, accounting for 17% of China's domestic grain production. Based on our estimates, China's food self-sufficiency declined to 86% in 2014 from 93% in 2008. (Page 9)

SCARCE WATER BUT CHEAP PRICE

25%/17%

Despite China's average water resources per capita being only 25% of the global average, China's current water and waste water tariff is only 17% of the average of comparable countries. (Pages 44 and 45)

UNDER INVESTED BUT CATCHING UP

1.7% OF GDP / **US$6,798** PER CAPITA INCOME

China only invested 1.7% of its GDP in the environmental industry in 2013, vs. 2.0% for Japan in 1975. Major developed countries enacted a series of environmental laws when their per capita GDP reached US$5-10k, we believe China is at a new phase (2013 per capita GDP of US$6,798) where it can and it must increase its investment in environmental protection. (Page 59)

TO BECOME THE NEXT PILLAR INDUSTRY

2016-2020 TOTAL INVESTMENT est. **RMB8.2TRN**

Assuming China to invest 2.0% of its annual GDP in 2016-2020, in line with the level that US, Germany and Japan had spent at the peak of cleaning up their pollution during 1970-80s, it would imply a total investment of RMB8.2 trn in 2016-2020, 60% higher than 2011-2015 and even greater than Australia's GDP (US$1.4trn) in 2014. (Page 17)

MARKET POTENTIAL UNLIMITED

RMB5.1TRN  VS **RMB4TRN** 

ENVIRONMENTAL INVESTMENT VS DEFENSE BUDGET IN 2011-2015

China's total investment (public and private) in the environmental industry is estimated to reach Rmb 5.1 trn in 2011-2015 (the 12th Five-year Plan), greater than the national defense budget of Rmb 4trn for the same period. After the announcement of Air Ten and Water Ten, we expect the Soil Ten to come in the near term and in total they would trigger investment over Rmb8.2 trn in 2016-20. (Page 16)

CLOSURE OF MORE POLLUTING CAPACITY

SMALL STEEL MILLS GENERATED **72%** SO_2

Small steel mills produced c.20% of China's total crude steel, but generated 72% of the industry's sulfur dioxide emissions in 2013. With the toughest Environment Protection Law effective 1 January 2015, the permanent closure of more marginal capacity should be expedited. (Pages 20 and 35)

WHAT ARE THE TARGETS?

REDUCE CO_2 EMISSION BY **3.1%** IN 2015

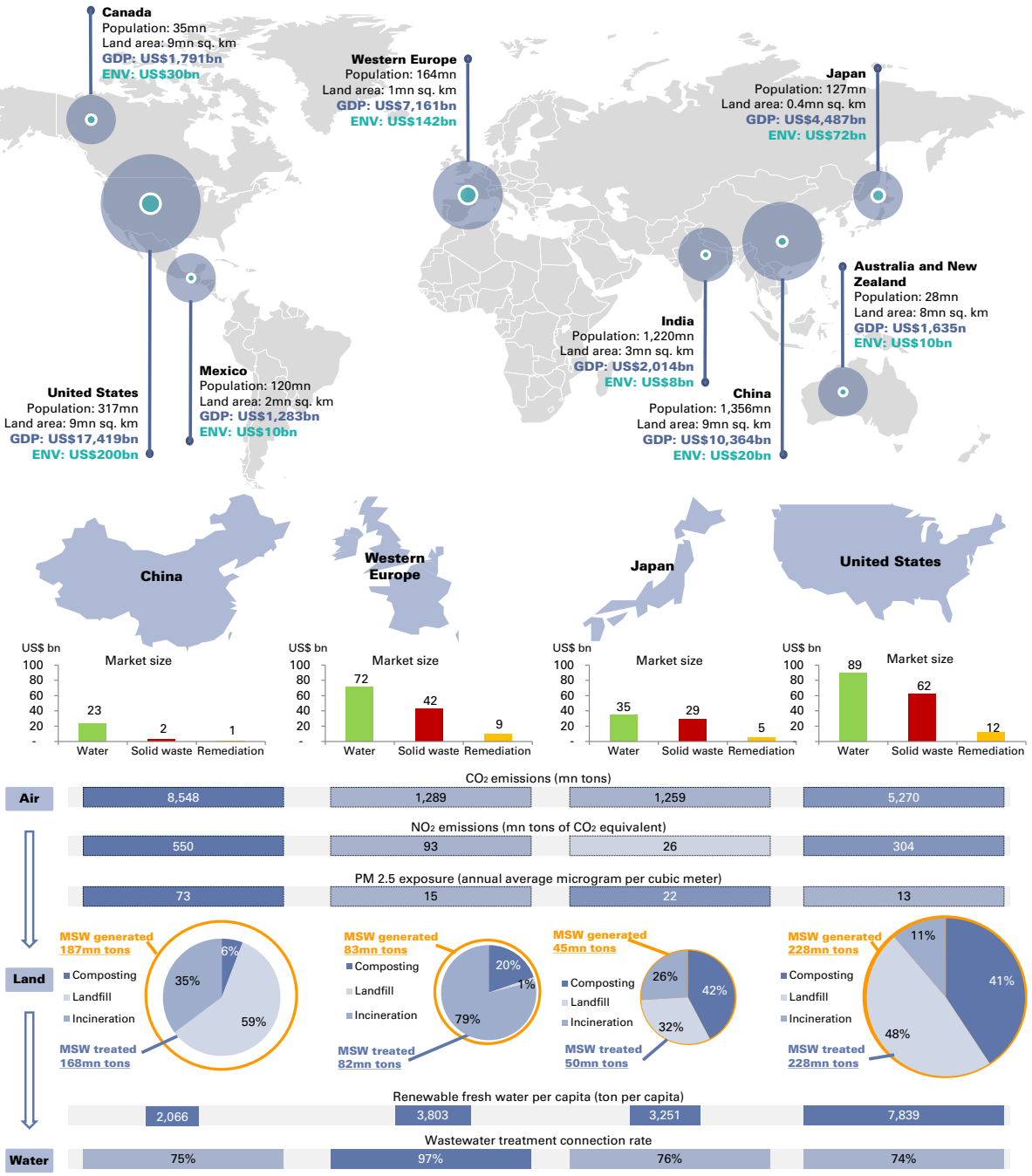
China aims to reduce CO_2 emissions by 3.1%, COD and NH by 2%, SO2 and NOx by 3% and 5%, respectively ,in 2015. China also plans to achieve 85% and 80% treatment ratios for municipal waste water and solid waste by 2015. (Pages 36 and 37)

CHANGING ENERGY MIX

% FROM NON-FOSSIL **21%->31%->38%**

We estimate China's power generation from non-fossil energy will grow from 21% of total generation in 2010, to 31% in 2015E, and ultimately to 38% in 2020E. Nuclear, wind and solar are likely to see rapid expansion: our GS analysts estimate from 2015 to 2020: China's **nuclear** power generation will grow at a CAGR of 12%; cumulative **wind** installed capacity up by 7-fold to 210GW; and total **solar** installation more than doubled to 100GW. (Page 39)

Exhibit 8: Global environmental market snapshot: China market's potential is tremendous



Note: GDP, land area and population (2014; Goldman Sachs Global Investment Research or World Bank), ENV (Environmental protection service market size; ECOTEC or USITC, 2010), MSW (municipal solid waste, OECD, 2013), market size refers to environmental protection service (USITC, 2012), emissions (EPA, OECD or World Bank), revenue (Bloomberg, latest FY).

Source: World Bank, ECOTEC, StEP Initiative, UNU-IAS SCYCLE, OECD, U.S. International Trade Commission, Goldman Sachs Global Investment Research.

Why now?

- China's efforts to curb pollution at an inflection point
- China's worst pollution is in its soil, not its air
- Government's evolving role: From investor to regulator
- New financing approaches to trigger multiplier effect
- Easing employment pressure helping tackle pollution

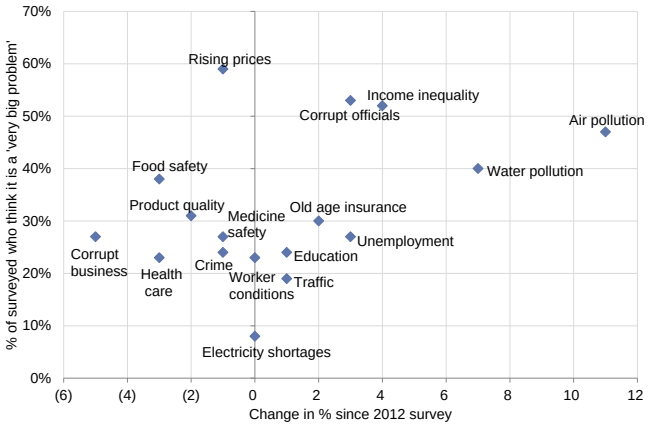
Why China can and must clean up now

China's efforts to curb pollution are at an inflection point

– *Rising social awareness and pressure have left policymakers no choice but to act now*

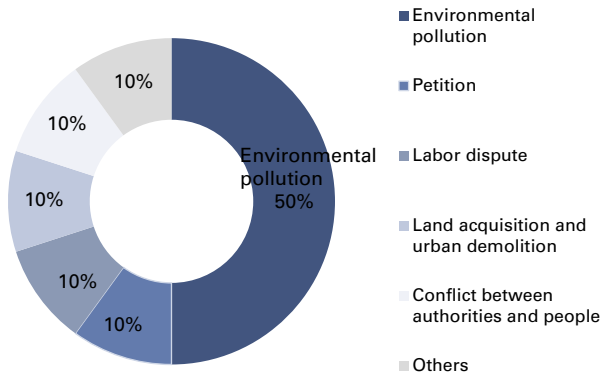
China has maintained its unwavering focus on achieving rapid economic growth, but this has also resulted in severe pollution, which has become a major concern for the Chinese people. In fact, according to the Chinese Academy of Social Sciences, pollution-related concerns were behind half of the large-scale protests in China during 2013, making pollution the leading cause of social instability.

Exhibit 9: Pollution is a key concern for China's people…
% surveyed who believe the issue is a very big problem, change, China, 2013 survey



Source: Pew Research Center.

Exhibit 10: …and a major factor behind social instability
Causes of mass disturbances (>10,000 people) in China, 2014



Source: Beijing News, Report on the Development of China's rule of law (2014).

China's worst pollution problem is in its soil, not its air

– *Soil pollution is impacting China's food security*

Public concern about pollution seems primarily focused on air and water pollution, and this is not surprising given the relatively easier access to information on air and water quality. However, China's worst pollution problem is in its soil, not its air. China's soil pollution has been significantly underestimated despite its much broader and more complex impacts on daily life such as the safety of groundwater and heavy metal contamination of agricultural production. More importantly, air pollution can be reduced by simply cutting toxic emissions, while reducing soil pollution requires curbs on pollution as well as a treatment process, which takes more time and demands more investment.

However, there is relatively lower awareness of soil pollution among policymakers and the public. For example, the 12th Five-Year Plan only set aside US$4.8 bn to address soil pollution, which is a fraction of the US$277 bn the State Council allocated to alleviate air pollution in 2013-17.

China had no official statistics on soil pollution until April 2014 when part of the results of a national soil pollution survey was released for the first time.

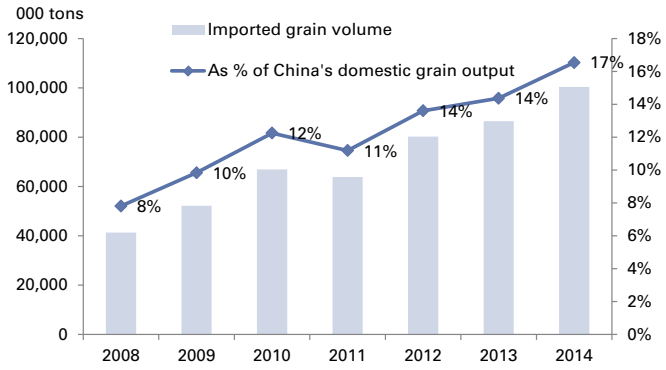
That survey, which was conducted by the MEP and the Ministry of Land and Resources (MLR) and carried out in 2005-2013, found that 16% of China's soil was polluted beyond acceptable standards, and 19.4% of China's total arable land (65mn out of 334mn acres) was badly contaminated by heavy metals. As the government estimates 300mn acres of

arable land is needed to maintain the nation's food security, declaring the 65mn acres of polluted land unfit for food production would push China's total arable land 31mn acres (10% of its total arable land) short of its self-defined "red line" of 300mn acres.

Severe soil and water pollution have had a profound impact on China's food supply and safety. The Ministry of Environmental Protection (MEP) estimates that heavy metal contamination affects 12mn tons of grain in China every year, which is enough to feed 24mn people, equal to the population of Australia. In 2013, the discovery of rice tainted with cadmium in Guangdong and Hunan triggered panic buying of Thai rice.

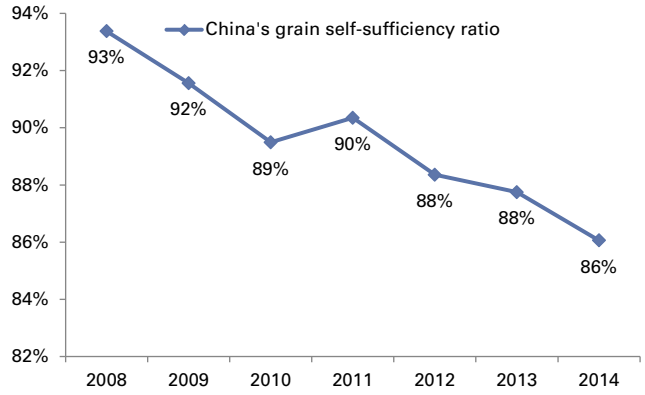
The rising pollution of China's arable land and increased land erosion has driven China to become a major food importer, especially for grain. In only seven years (2008-2014), China's annual grain imports more than doubled from 41.3mt to 100.4mt, accounting for 17% of China's domestic grain output. More worryingly, China's grain self-sufficiency declined from 93% in 2008 to 86% in 2014, despite the fact that the number of annual new births was largely stable during the same period.

Exhibit 11: In 2014, imported grain accounted for 17% of China's domestic grain output...



Source: CEIC.

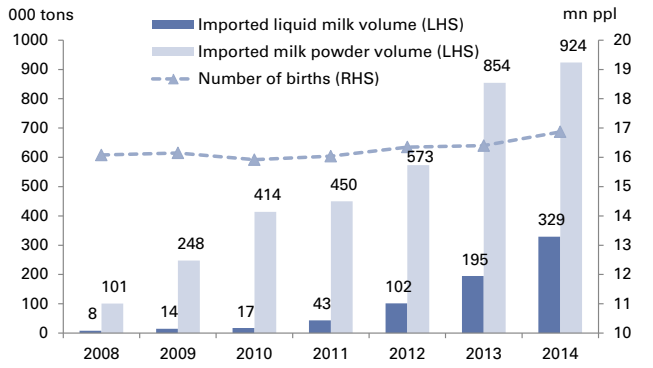
Exhibit 12: ...and, more worryingly, China's grain self-sufficiency has been declining



Source: CEIC, NBS, Goldman Sachs Global Investment Research

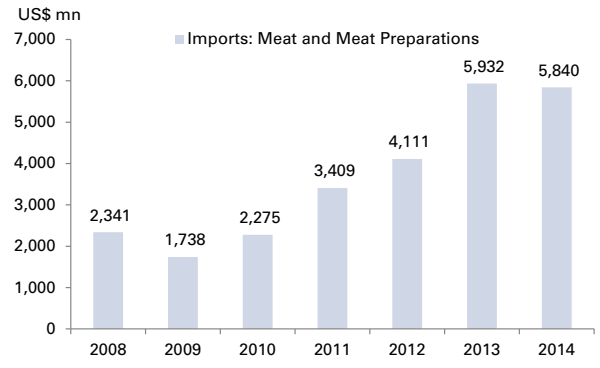
A series of food safety scandals such as contaminated baby formula in 2008, contaminated strawberries in 2011 and cadmium rice in 2013 have put food safety and pollution on the list of top concerns for many households in China. The ongoing quality degradation of domestic agriculture production, combined with rising social awareness, have boosted demand for clean and safe food, especially dairy products, beef and rice.

Exhibit 13: In 2008-14, China's imports of milk powder/liquid milk grew 9X/40X while births were stable



Source: CEIC, NBS.

Exhibit 14: In 2008-2014, China's imports of meat grew c.2.5X



Source: CEIC, WIND.

Of course, China's rapid urbanization, industrialization and rising consumption are key reasons for such strong food import growth, but we believe severe soil pollution and land degradation are having a real impact on China's long-term food security that could have profound economic and geopolitical consequences for China and the rest of the world.

Government's evolving role: From investor to regulator

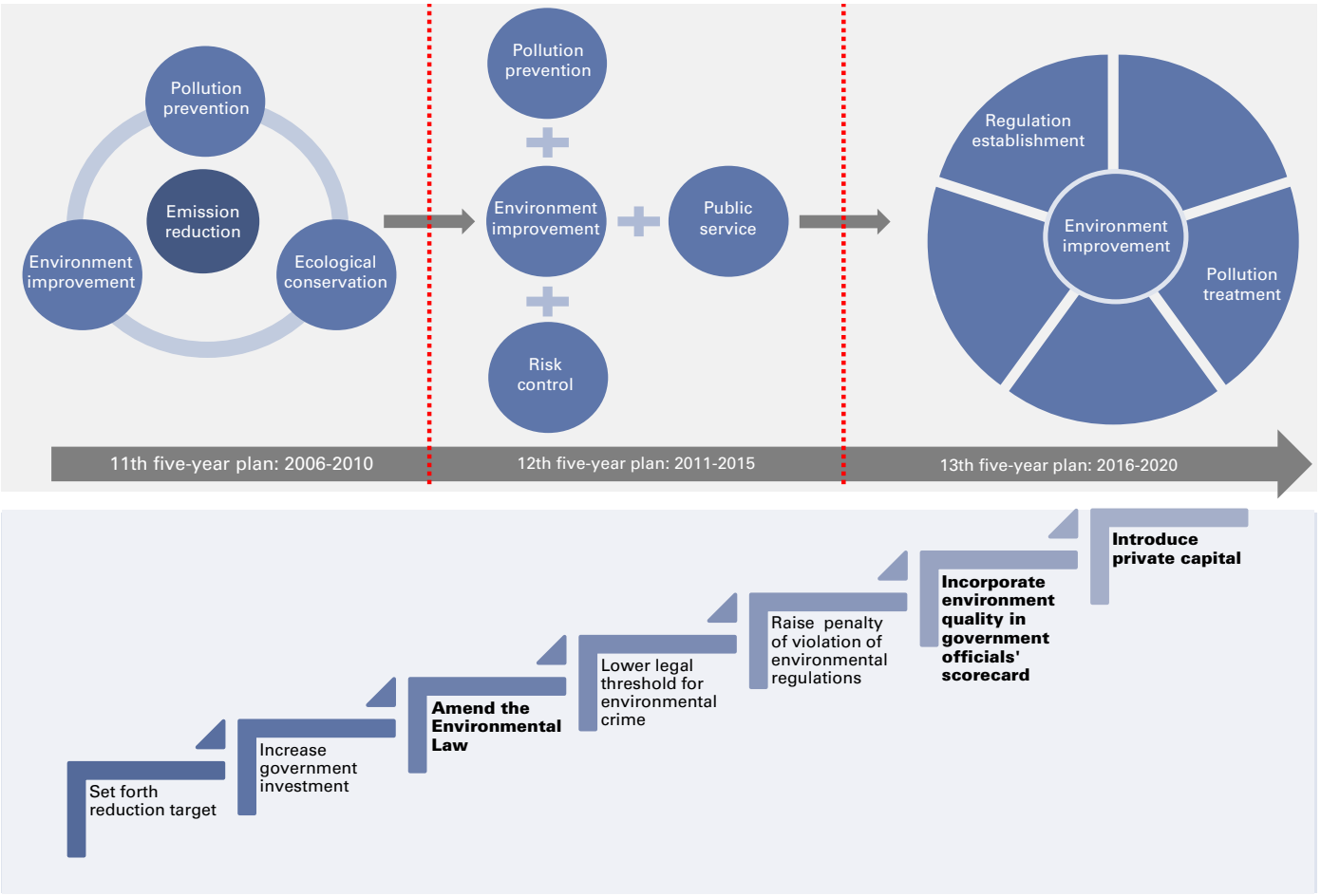
– *Why we believe the MEP now has a clear mandate to enforce compliance and government investment should have a multiplier effect*

The model of government-led investment in environmental protection has proven inefficient. Key changes brought about by the new central government since 2012 have been the shift in the government's role from an investor to a real regulator through the introduction of new laws and regulations, the reinforcement of existing laws, and the further opening up of the environmental sector to private investment. We believe these moves will help raise the low efficiency of the government's environmental investment and create a supportive market mechanism that will attract private capital and allow it to lead investment in environmental protection and industry improvements.

Against this backdrop, China has introduced a series of milestone environmental policies and regulations that feature concrete and actionable measures as well as specific targets to be achieved in the next few years. Among them, the Air Ten, the New Environmental Law and the Water Ten are the most important (see Exhibits 89-91 for details).

More importantly, the new government has included environmental metrics in the performance assessment of local government officials, which should promote effective enforcement and implementation of the new laws, regulations and initiatives.

Exhibit 15: Chinese government's role change should lead to more (and more efficient) investment in the environment
Different strategies to fight pollution (2006-2020)



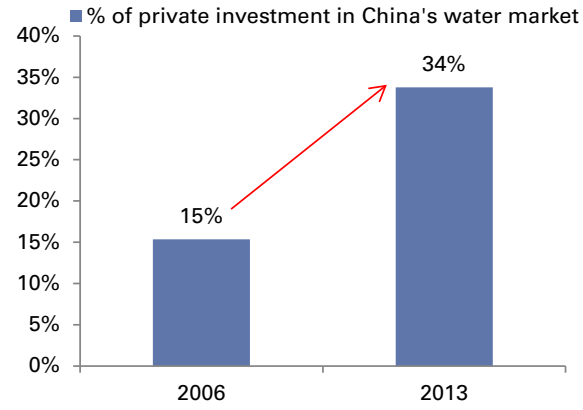
Source: MEP, Goldman Sachs Global Investment Research.

New financing approaches to trigger multiplier effect

– *New funding opportunities to expedite the cleanup efforts*

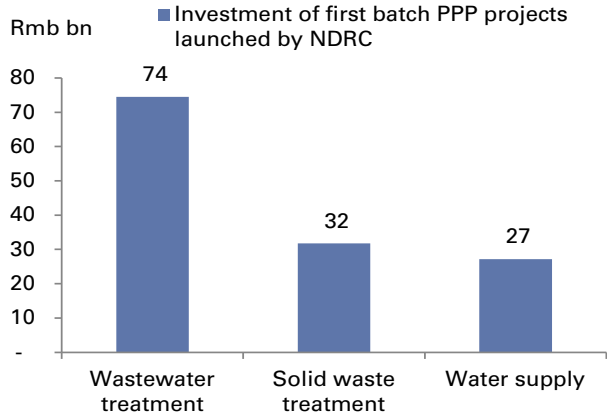
We expect public-private partnerships (PPP) and third-party treatment (TPT) to increase the capacity and efficiency of public goods supply through the establishment of long-term profit- and risk-sharing schemes with private investment in the form of operating concessions, government purchases, and joint ventures. As a result, we believe more high-efficiency private capital will be attracted to the environmental protection industry, helping create a multiplier effect for government spending.

Exhibit 16: Private capital mushrooming in water market



Source: PPI World Bank.

Exhibit 17: PPP investment by type



Note: Only projects launched by May 2015 are included.

Source: PPI World Bank.

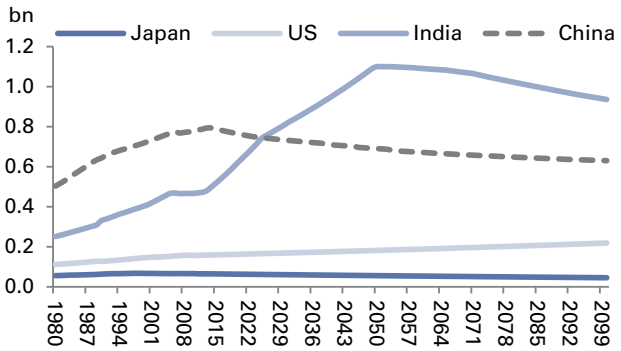
Easing employment pressure helping tackle pollution

– *Thanks to China's changing demographic outlook, regulators should be able to close pollution-generating industrial capacity without repercussions on social stability*

Due to moderating labor supply growth, employment pressure has become much less of an issue for the first time since 1978.

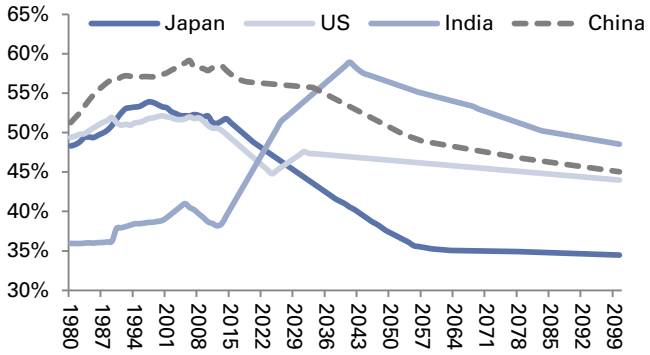
Although China has the world's largest population, it ranks low vs. the United States, India and Japan in terms of its working population growth trend and its working class as a percentage of its total population.

Exhibit 18: Working population trend



Source: CEIC, UN.

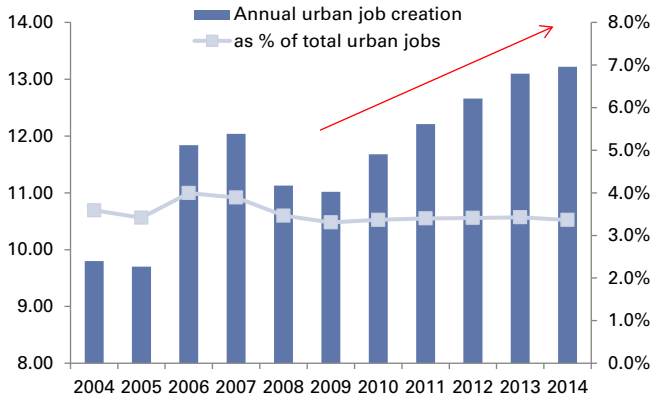
Exhibit 19: Working population as % of total population



Source: CEIC, UN.

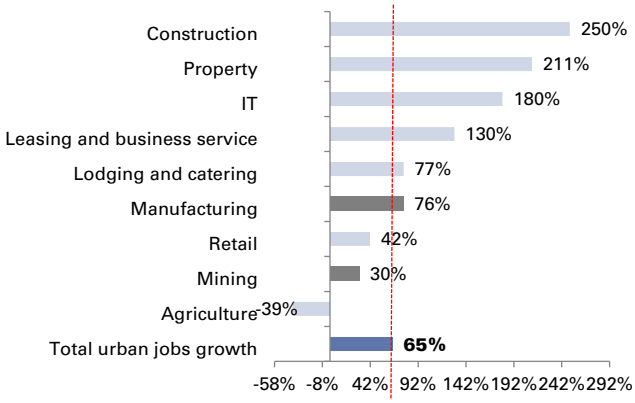
Since the global financial crisis in 2008, China has posted steady growth in terms of annual jobs creation. Also important to note, despite the relatively weak economic growth in 2014, China achieved its full-year job creation target of 10mn by September and added 13mn jobs for the full year. Much of this new jobs creation is coming from services- and internet-related "new economy" companies.

Exhibit 20: Post the global financial crisis in 2008, China has achieved steady growth in annual jobs creation



Source: CEIC.

Exhibit 21: New jobs growth from manufacturing and mining was outpaced by that from the services sector
2003-2013 10-year new job growth rate



Source: NBS.

This demographic development trend offers China precious leeway to reform its economic growth model and remedy its environmental ecosystem without facing tremendous employment pressure.

How big is the opportunity?

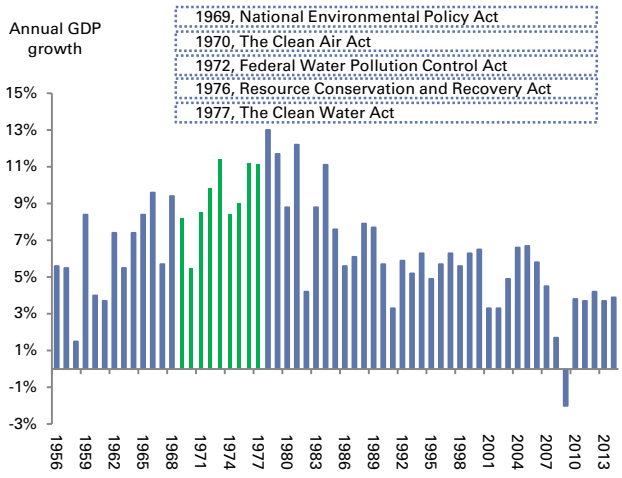
- An addressable market worth Rmb8.2 trn by 2020
- Soil remediation, solid waste and wastewater treatment have the biggest growth potential
- Key beneficiaries include leaders in commodities, agriculture, clean energy, autos and catalytic materials

A multi-trillion dollar opportunity across multiple sectors

Greening up is supportive to L-T growth, investable and profitable

The US and Japan have shown that, although environmental cleanups can put pressure on economic growth over the short term, the technology innovation and transition to a more sustainable growth model brought about by cleanup initiatives lead to significant upgrades to the structure of economies over the long term. We believe China is likely to follow the same development trajectory. If managed properly, China's green-up efforts will help it develop a bigger environmental protection and energy conservation industry through innovation. Greening up should also help China move further up the global manufacturing value chain by phasing out low-valued-added polluting capacity.

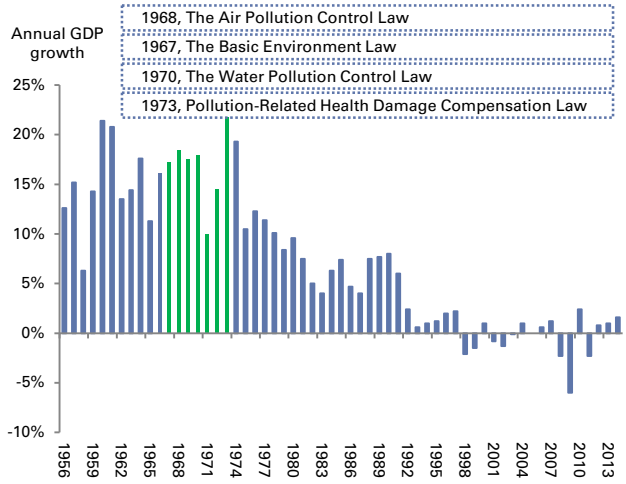
Exhibit 22: Greenup vs. growth – the US



Note: Green bars stand for time periods when environmental protection laws were enacted.

Source: CEIC.

Exhibit 23: Greenup vs. growth – Japan



Note: Green bars stand for time periods when environmental protection laws were enacted.

Source: CEIC.

In this section, we analyze the direct and indirect investment opportunities brought about by China's cleanup efforts over the next 5-10 years.

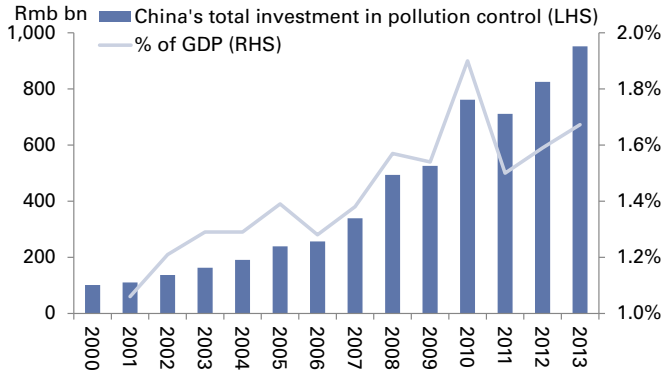
China environment: An Rmb8.2 trn addressable market by 2020

– *Sizing up the overall potential and implications by subsector*

We estimate environmental protection and cleanup will grow into a Rmb8.2 trn market in 2016-2020 (the period covered by the 13th Five-Year Plan).

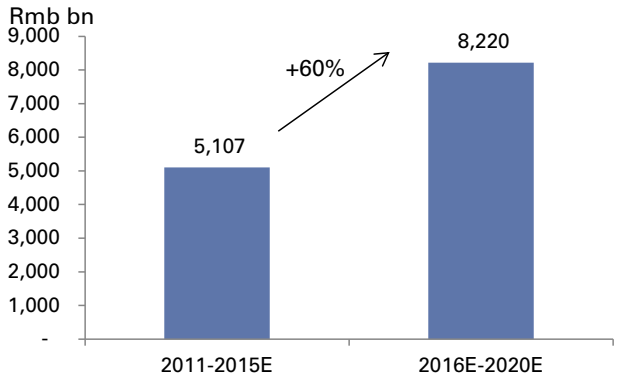
China's environmental investment/GDP ratio of 1.5% is lower than the ratios held by the major developed countries when they ramped up their anti-pollution efforts about 40 years ago. Moreover, given the relative severity of China's pollution problem, we believe it will need to invest relatively quickly to clean up its pollution over the next 5-10 years. Assuming China invests 2.0% of its annual GDP during the 13th Five Year Plan period (2016-2020) – in line with spending by the United States, Germany and Japan at the peak of their respective pollution cleanup phases during the 1970-80s – would imply a total government investment of Rmb8.2 trn in 2016-2020, representing a 60% increase from 2011-2015.

Exhibit 24: China has under-invested in environmental protection, but it has been catching up…



Source: China Statistical Yearbook on the Environment, Wind.

Exhibit 25: …and we expect spending to rise 60% in 2016E-2020E from 2011-2015E



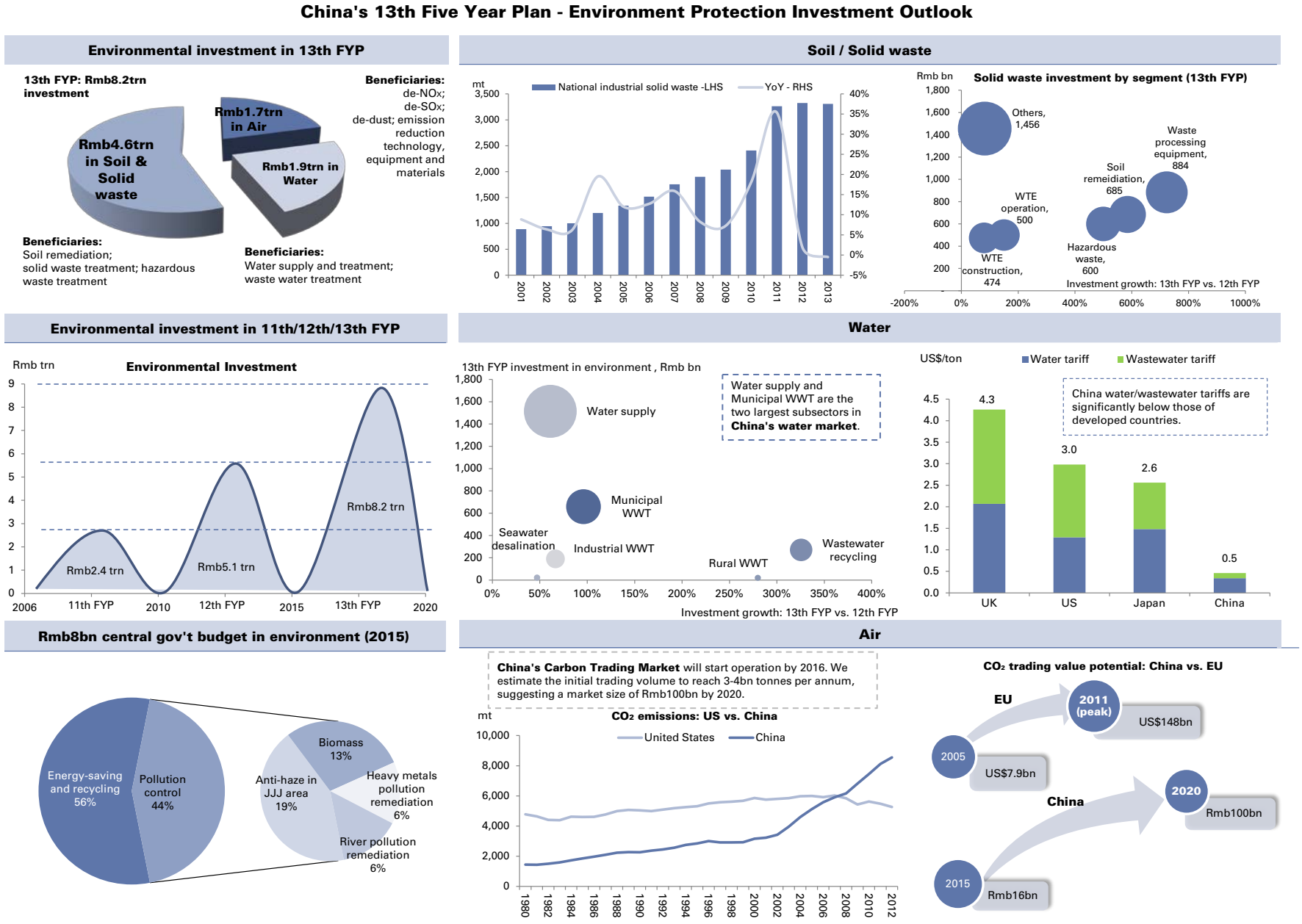
Source: MEP, Goldman Sachs Global Investment Research.

The changing of the Chinese government's role from that of an investor to a supervisor and promoter of PPPs and TPT should create an investment multiplier effect, i.e., the government's direct investment in this industry, combined with the supportive investment environment, should attract more private capital into the environmental protection industry, creating a multi-trillion dollar industry value chain covering pollution/emission reduction, ecosystem (water and soil) treatment, alternative energy and system monitoring business.

We expect such massive investment by the government, combined with its new initiatives to encourage and attract private investment, will create an Rmb8.2 trn addressable market over the next five years.

We believe soil remediation, solid waste treatment and water treatment have the biggest growth potential. While air pollution controls should lead to even stricter emission reduction measures, such controls do not involve a treatment process, so we expect investment opportunities to focus on air quality monitoring equipment and technology, the reduction of carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrogen dioxide (NO_x) emissions, and carbon trading.

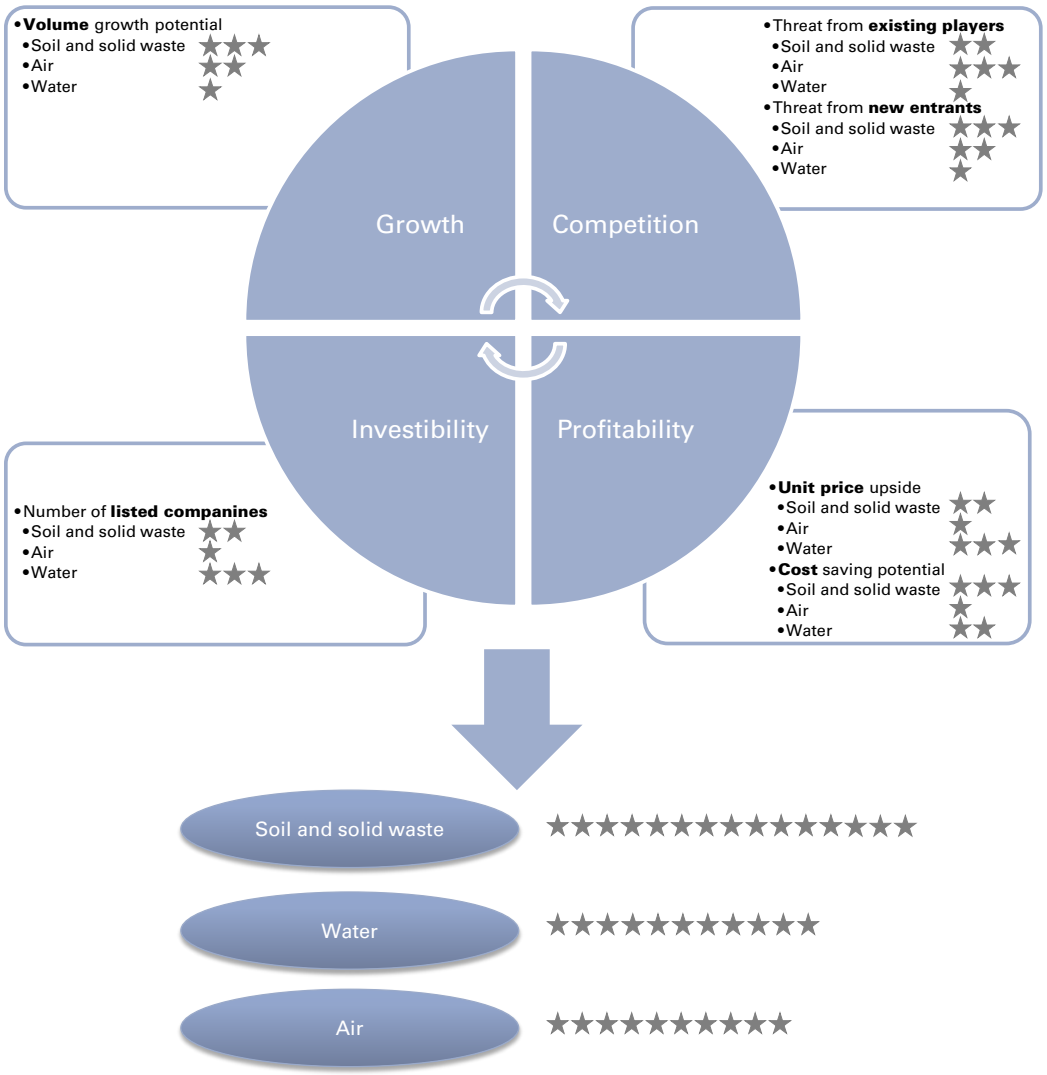
Exhibit 26: We forecast China to invest Rmb8.2 trn in environmental protection during the 13th Five-Year Plan, up 60% from the 12th Five-Year Plan
Soil and solid waste should see the largest investment, accounting for 56% of the total



Source: MEP, Goldman Sachs Global Investment Research.

We compared the investment opportunities of the various environmental protection subsectors by looking at their growth potential (volume and prices outlook) and competitive landscape (entry barriers and market concentration). We believe **hazardous waste treatment offers the most attractive potential** due to its significantly underestimated market size and the high entry barrier represented by its strict licensing system. On the other hand, despite the meaningful upside opportunities to both its volume and pricing outlook, we expect the water supply and treatment market to remain competitive, keeping its investment return relatively low.

Exhibit 27: The comparison of environmental protection subsectors
Market analysis of three sub-sectors: Soil, air and water pollution remediation



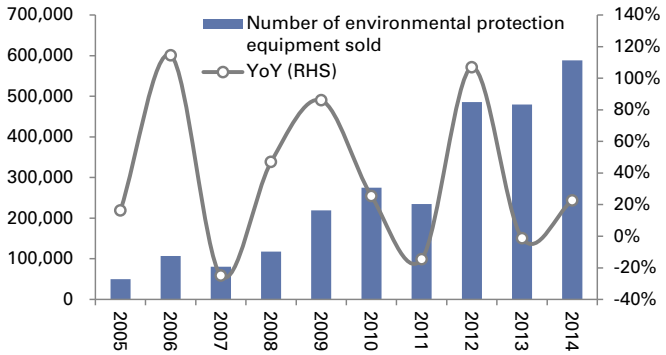
Note: Grey stars represent the relative favorability of each industry's position.

Source: Goldman Sachs Global Investment Research.

Environmental survey, monitoring and assessment equipment

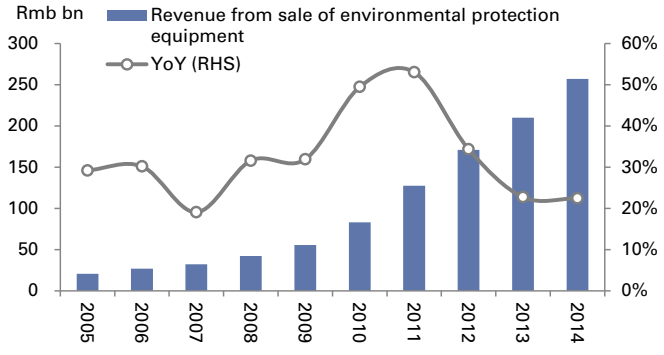
The environmental equipment manufacturing sector is another key industry best positioned to grow as a result of China's upcoming investment in environmental cleanup and protection. In order to reduce pollution across the ecosystem, as a prerequisite, China needs a comprehensive information system to gauge the magnitude of the current pollution situation. Therefore, we see significant growth potential for manufacturers of pollution monitoring, survey and assessment equipment as well as equipment and facilities used to reduce pollution. In 2005-2014, China's environmental equipment sales surged 12X to Rmb257 bn, and we forecast the industry to grow its revenue by another 20% yoy to Rmb308 bn in 2015E. Based on our expectation of 60% environmental protection investment growth in the 13th Five-Year Plan (2016-20E) from the 12th Five-Year Plan period, we believe environmental equipment manufacturers are poised to sustain their strong growth momentum. We expect industry leaders such as Sound Environmental and Focus Technology are best positioned to reap this strong growth potential.

Exhibit 28: The number of environmental protection equipment sold has increased rapidly…



Source: Wind.

Exhibit 29: …so have revenues for the industry



Source: Wind.

Other industries: Implications and impact

– *Commodities, agriculture/food safety, clean energy, auto and catalytic materials*

Aside from the direct environmental protection industry, we also see investment opportunities in other industries like commodities, agriculture and auto manufacturing where pollution and pollution control are reshaping the industries in terms of capacity, cost, competition, profitability and return outlook. On the other hand, stricter environmental protection standards will bring new growth opportunities to industries including clean energy and catalytic materials, etc.

Commodities

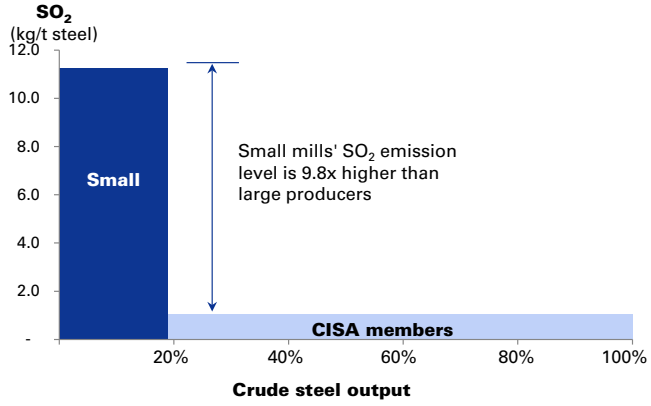
– *Industry leaders compliant with environmental regulations are set to benefit*

– *Stricter emission standards to expedite marginal capacity curtailment and push up the industry cost curve*

As the major source of pollution in China, the commodities industry is set to undergo significant transformation under the country's renewed efforts to clean up the environment. We expect stricter emission standards to reshape China's commodities industry in terms of cost, capacity, competition, profitability and return outlook.

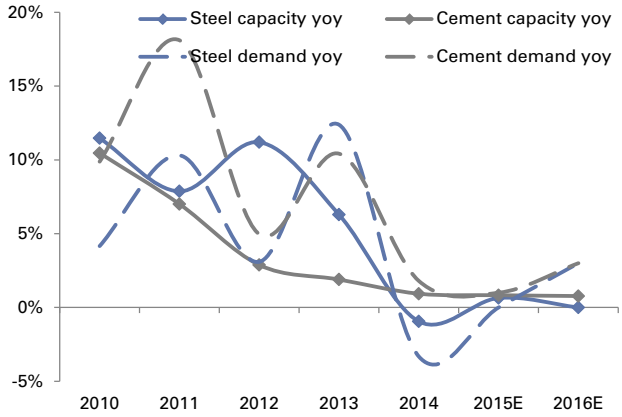
To a large extent, China's decade-long overcapacity is also due to its failure to ensure marginal producers meet environmental protection standards. For example, a key reason why small private steel producers have been able to survive and even thrive in the past decade has been the cost advantage they have reaped from not complying with emission control requirements. Going forward, when Chinese regulators begin to make sure each and every producer meets emission control standards, most small private commodities producers will have to: 1) increase their investment in emission control facilities, equipment and technology; and 2) cope with rising operating costs when turning on such facilities. This should lead to faster elimination of marginal capacity, helping ease the prolonged oversupply situation and benefiting industry leaders that have been compliant with environmental regulations.

Exhibit 30: Smaller steel mills pollute much more relative to their steel production than larger mills (2013)
In 2013, small steel mills produced c.20% of China's steel but 72% of the industry's SO_2 emissions



Source: MEP, CISA.

Exhibit 31: Environmental pressure should help ease China's decade-long cement/steel overcapacity



Source: Digital Cement, Mysteel, Goldman Sachs Global Investment Research.

Agriculture/food safety

– *Pollution (soil contamination in particular) impacting China's food security*

– *Chinese demand for safe and organic food is likely to rise further, affecting the global supply-demand balance*

Please refer to page 9 for details.

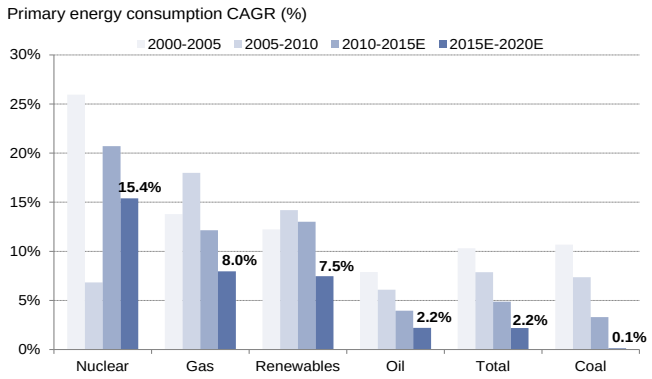
Clean energy

– *China aims to lift clean energy to 38% of total primary energy capacity by 2020*

– *Nuclear to be the fastest-growing new energy segment*

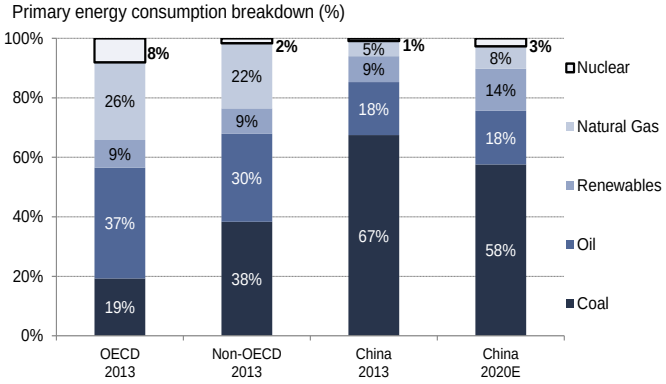
China will continue to reduce the role of coal in its primary energy consumption by promoting the development of clean energy including nuclear power, hydro, wind, solar, biofuel and natural gas. Our Energy Research Team estimates the share of coal-fired power generation will decline to 62% of China's total power generation in 2020 from 79% in 2010. This would require power capacity of wind, nuclear, solar, natural gas and biofuel to grow multiple times from now to 2020. In terms of primary energy mix, among the clean energy basket, nuclear should be the fastest-growing primary energy, contributing 3% of total primary energy consumption in 2020E, up from 1% in 2013. Currently China has 23 operating nuclear power plants with 27 under construction, ranked first globally in terms of capacity under construction (as of June 30, 2014).

Exhibit 32: Nuclear to be the fastest-growing primary energy source in China
Primary energy consumption CAGR (%), 5-year periods over 2000-2020E, China



Source: BP Statistical Review, CEC, National Bureau of Statistics (NBS), NEA, Goldman Sachs Global Investment Research.

Exhibit 33: Changing energy mix – China vs. OECD
Primary energy consumption breakdown, OECD, non-OECD, China, 2013 and 2020E



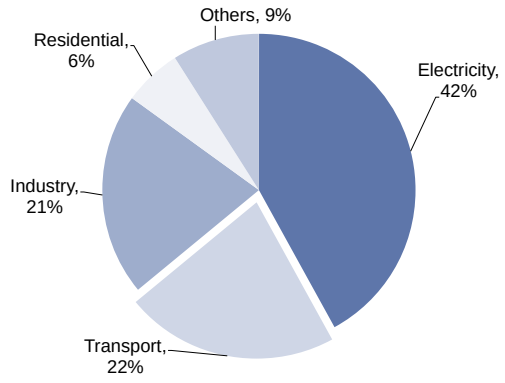
Source: BP Statistical Review, CEC, NBS, National Development and Reform Commission (NDRC), NEA, Goldman Sachs Global Investment Research.

Auto and catalytic materials

- *China is about two stages, or seven years, behind Europe on its commercial vehicles emission standards*
- *China's emission standard upgrades should push up the cost of vehicles while benefiting suppliers of emission equipment and materials*

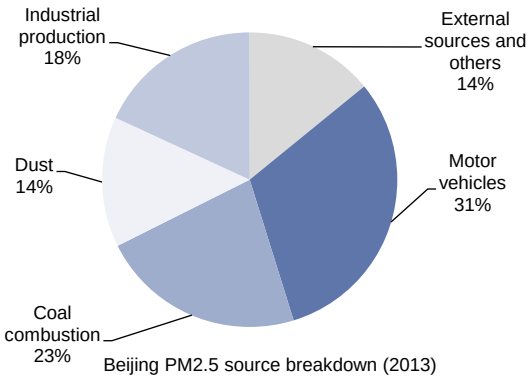
In 2013, the transportation sector accounted for 22% of global CO_2 emissions, and major developed nations are under pressure to reduce vehicle CO_2/kg 30%-40% by 2025. As the country with the biggest annual auto sales volume and the most CO_2 emissions, China is now under particular pressure to upgrade its commercial vehicle emission standards in a bid to tackle its emission reduction and air quality control challenges.

Exhibit 34: The transportation sector accounts for a large slice of global CO_2 emissions
Greenhouse gas emissions by sector (2013)



Source: METI.

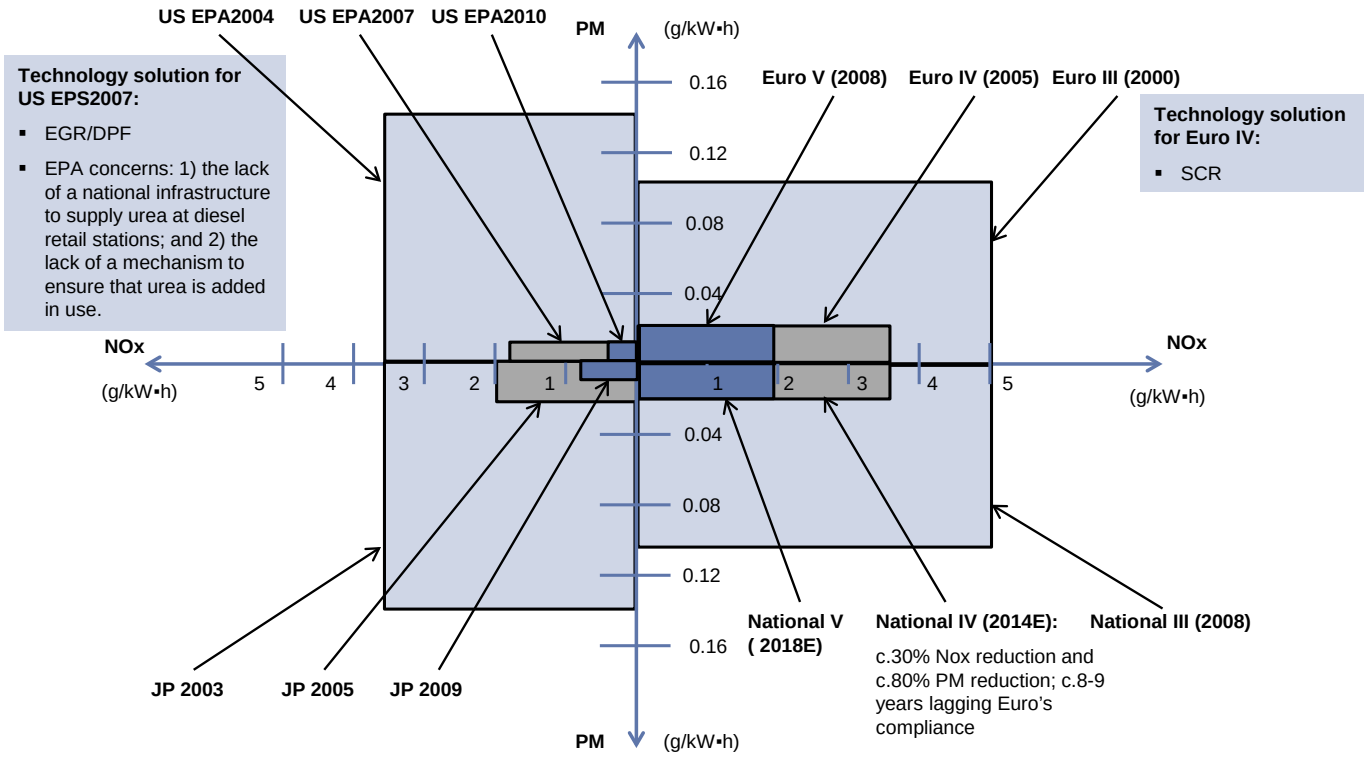
Exhibit 35: Vehicle emissions account for 31% of Beijing's PM2.5 pollution
Beijing PM2.5 pollution source mix



Source: Beijing Environmental Protection Bureau.

Based on the current European emissions control standard, China is about two stages, or seven years behind. Given this gap and the increasing air pollution control policy tailwinds in China, our China Auto Research Team expects to see a strong emission upgrade cycle from commercial vehicles and off-road machinery in the coming decade (2015-2024). Our team also expects China to gradually upgrade its emissions standards to Euro VI (where Europe is now) by 2023, creating a Rmb100 bn emission upgrade market by 2024 at a CAGR of 14% from 2016. Such strong secular growth should benefit Weifu A/B, a leader in the emission upgrade products segment (engine optimization and after-treatment products).

Exhibit 36: China lags global peers in terms of commercial vehicle emission standards
Emission standard comparison



Source: EPA, MEP, Gao Hua Securities Research.

Catalytic and new materials: Another key beneficiary from emission standard upgrades would be catalytic materials, which are widely used in vehicle exhaust purification, industrial organic exhaust gas purification and catalytic combustion. In 2003-2012, Chinese rare earth catalytic materials consumption posted a CAGR of 21%, according to the Chinese Society of Rare Earths, primarily driven by China's efforts to upgrade its emissions standards.

Pollution in China – a primer

- China: Global growth engine, but also worst polluter
- Air pollution: Causes and industrial origin
- Water pollution: Grading and where it's worst
- Solid waste: Problem significantly underestimated

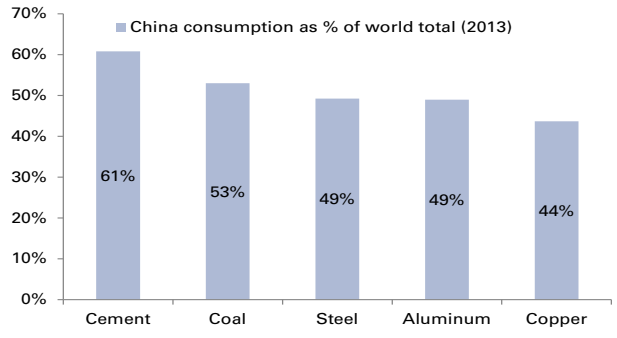
Pollution in China – a primer

China: Global growth engine, but also worst polluter

China's economy is large but heavily dependent on inputs of natural resources, particularly energy. In 2013, while contributing 15.4% of global output, China consumed 44%-61% of the world's copper, coal, steel, aluminum and cement. Over the past 30 years, China has also been consuming a relatively large amount of energy per unit of GDP. This resources- and energy-intensive growth model has resulted in China generating disproportionally more pollution relative to its contribution to global output, making it the world's worst polluter. According to the US Energy Information Administration, in 2006 China surpassed the US in carbon-dioxide emissions from energy, and in 2015 China's emissions will be double that of the US. *The Economist* estimates China's cumulative emissions from energy between 1990 and 2050 are around 500bn tons, roughly the same as the emissions of the rest of world from the beginning of the industrial revolution to 1970.

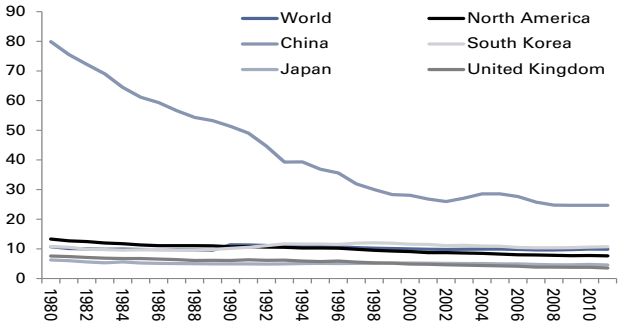
Air pollution is the environmental issue that attracts the most attention in China, but water and soil pollution are much more complex problems. While air pollution can be reduced simply by cutting toxic emissions, reducing water and soil pollution requires curbs on pollution as well as a treatment process, which takes more time and demands more investment.

Exhibit 37: China's consumption of various commodities
2013 data



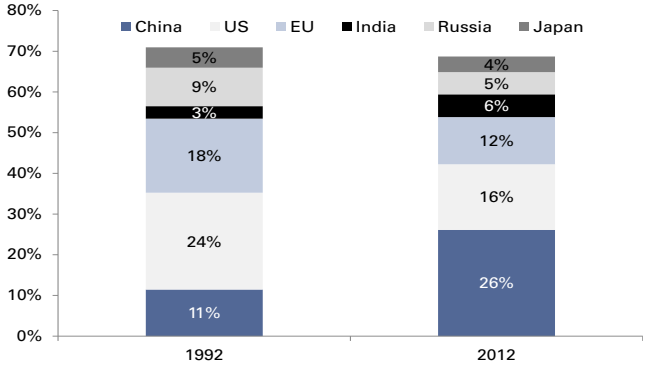
Source: Digital Cement, SXCoal, Mysteel, Goldman Sachs Global Investment Research.

Exhibit 38: China's energy intensity of GDP
Primary energy consumed per dollar of GDP (Btu pa, 2005 USD)



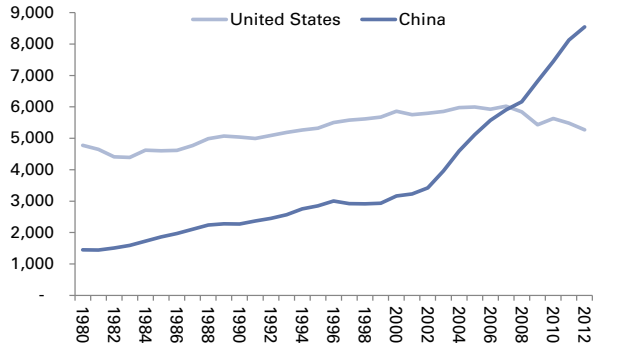
Source: EIA.

Exhibit 39: Global carbon dioxide emissions by country
% of world total carbon dioxide emissions



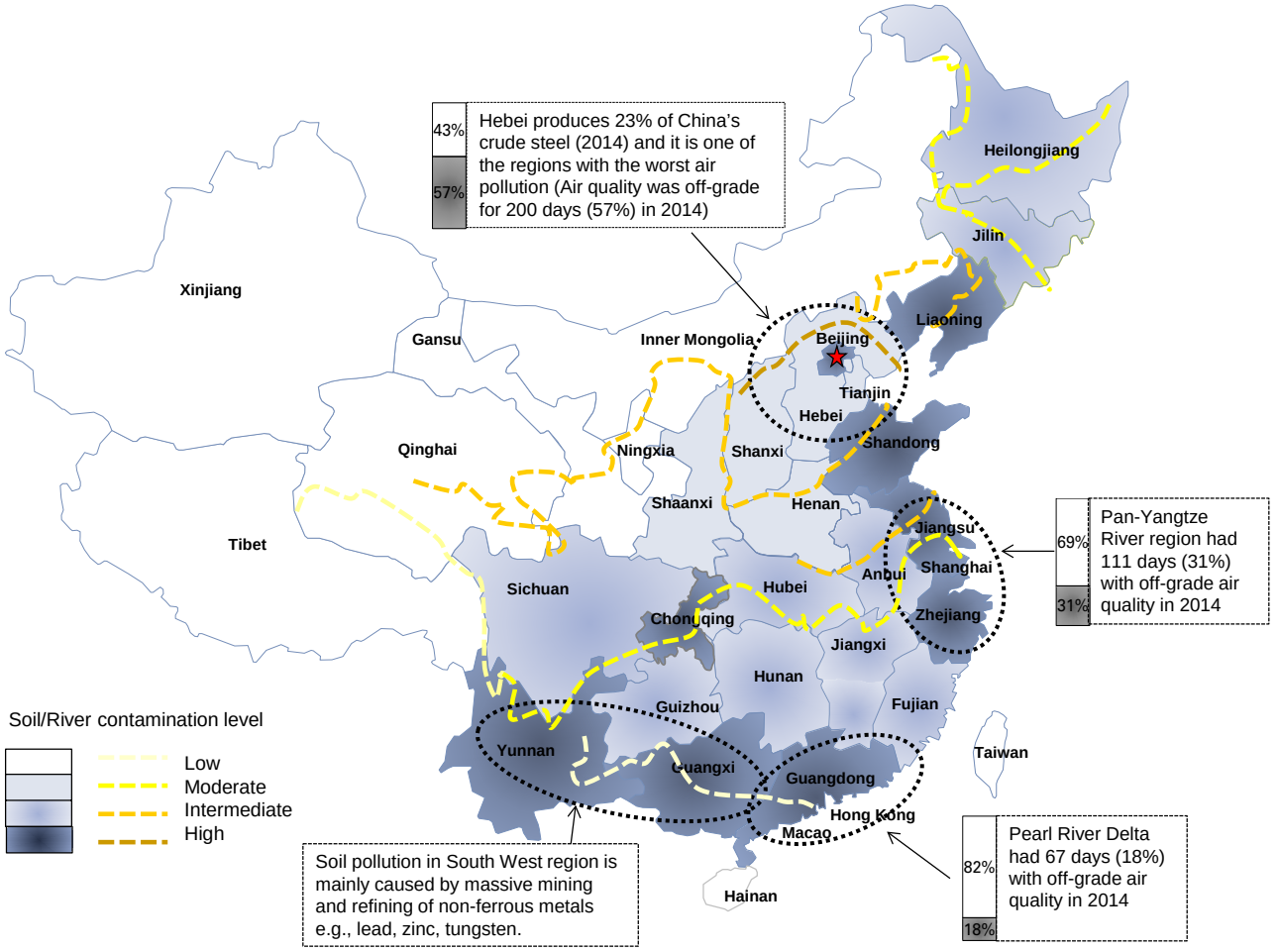
Source: EIA.

Exhibit 40: Carbon dioxide emissions: US vs. China
million metric tons



Source: EIA.

Exhibit 41: China's efforts to curb pollution are at an inflection point



AIR

35.9 days of haze
(national avg. in 2013)
Up >100% yoy
(2012 avg of 17.6 days)
Highest since 1961
44% of cities had acid rain

Best 10 cities 2014	Worst 10 cities 2014
Haikou	Baoding
Zhoushan	Xingtai
Lhasa	Shijiazhuang
Shenzhen	Tangshan
Zhuhai	Handan
Huizhou	Hengshui
Fuzhou	Jinan
Xiamen	Langfang
Kunming	Zhengzhou
Zhongshan	Tianjin

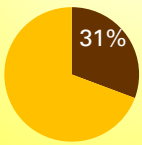
WATER

Water quality in 10 major rivers:

Good	Average	Bad
Pearl River	Zhemin rivers	Huai River
Yangtze River	Songhua River	Hai River
North-west rivers	Yellow River	Liao River
South-west rivers		

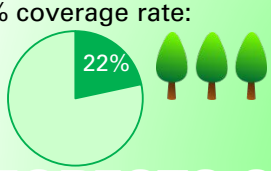
SOIL

Pollution in **South China > North China**
East China and Southwest: the most severe regions
218,900 hectares:
Net loss of arable land in 2010-2013;
2.95mn sqm (**31%** of total)
land is eroded by either wind or water

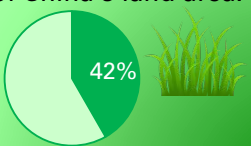


FORESTS & GRASSLAND

Forest area:
208mn hectares
% coverage rate:



Grassland area:
400mn hectares
% of China's land area:



Note: Data are based on 2014 China Annual Environmental Report unless otherwise stated.

Source: National Soil Pollution Survey, Ministry of Environmental Protection.

Air pollution: Causes and industrial origin

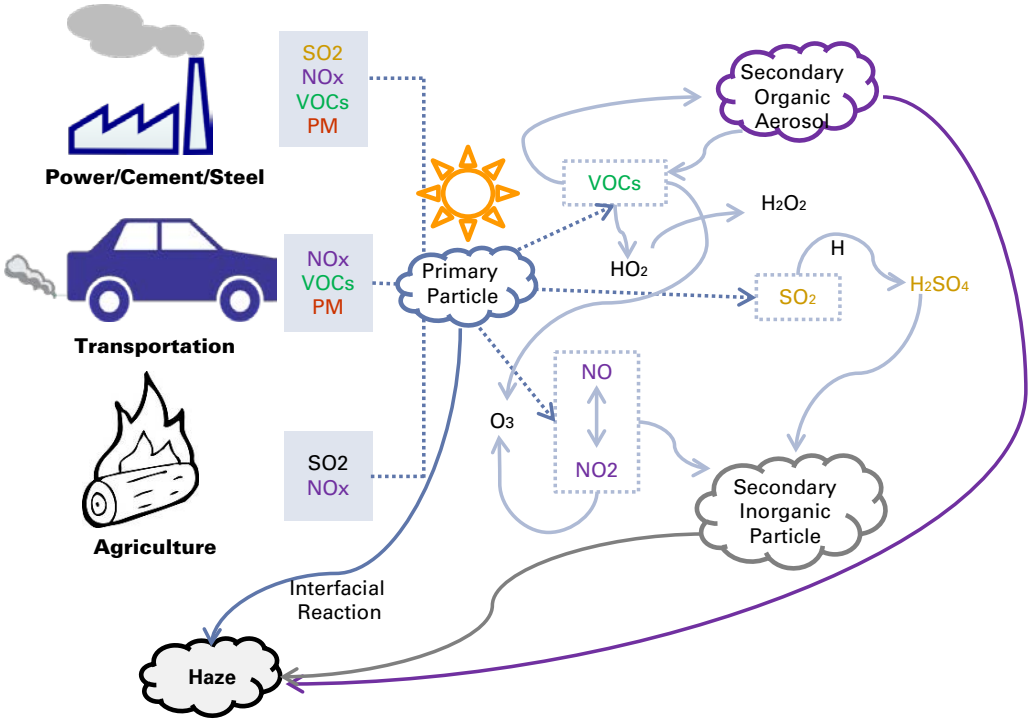
Air pollution is an atmospheric phenomenon, mostly observed as haze, which occurs when the concentration of smoke, dust, sulfur compounds, nitrogen oxides and carbon dioxide reaches a level that is harmful to human health or the environment. China uses an Air Quality Index (AQI) to measure air quality, and any reading above 100 is considered pollution.

Exhibit 42: China's Air Quality Index (AQI) and health implications

Numerical value	Air Quality Index	AQI and Color		Health concerns	Precautions
0-50	First	Good	Green	Air quality is considered satisfactory, and air pollution poses little or no risk	None
51-100	Second	Moderate	Yellow	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Unusually sensitive people should consider reducing outdoor activities
101-150	Third	Unhealthy for Sensitive Groups	Orange	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	The elderly, children and those with heart or lung disease should avoid prolonged outdoor exercises
151-200	Fourth	Unhealthy	Red	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.	The elderly, children and those with heart or lung disease should avoid prolonged outdoor exercises; the rest should reduce outdoor exercises
201-300	Fifth	Very unhealthy	Purple	Health warnings of emergency conditions. The entire population is more likely to be affected.	The elderly, children and those with heart or lung disease should stay indoors; and the rest are suggested to reduce outdoors activities
>300	Sixth	Hazardous	Maroon	Health alert: everyone may experience more serious health effects	Entire population should be warned of outdoor activities; the elderly and children are suggested to avoid physical exhaustion

Source: MEP.

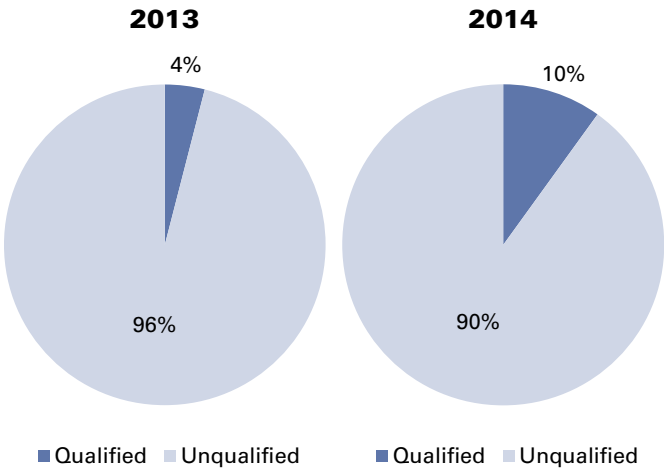
Exhibit 43: How is haze formed?



Source: China PM2.5 (www.pm2.5.org.cn), Goldman Sachs Global Investment Research.

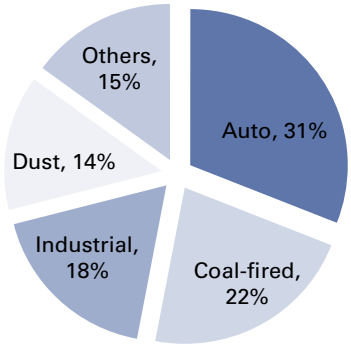
China's air quality has deteriorated rapidly since 2012 as evidenced by the surging number of haze days. There were 35.9 haze days on average in China during 2013, the highest level since 1961. In 2013, among 74 monitored cities, the number of days with very unhealthy or hazardous air quality totaled 677, making 2013 the worst year for air pollution in the past 50 years. In 2014, out of 161 monitored cities, only 16 reached the national standards of urban air quality, with a pass rate of 10% (4% in 2013).

Exhibit 44: 2013/14 air quality in monitored cities



Source: China Statistical Yearbook on the Environment.

Exhibit 45: Sources of air pollution in Beijing



Note: Based on survey result released on 2014-2015.

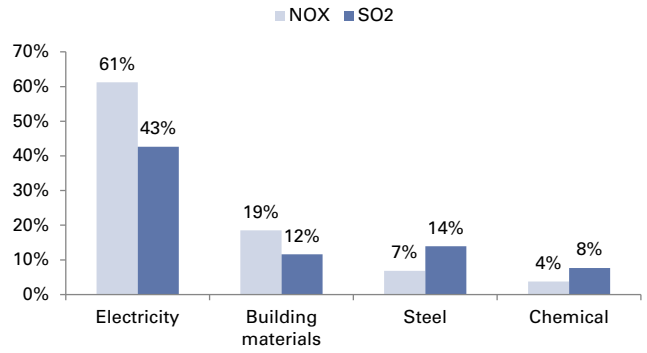
Source: Beijing Environmental Protection Bureau.

A newly released (April 2015) study of air pollution sources in nine major cities showed the major sources of pollution are motor vehicles, industrial production, coal, and dust, accounting for 85%-90% of particulate matter (PM) found in the air. Motor vehicles represent the primary source of pollution in Beijing, Hangzhou, Guangzhou, and Shenzhen, while in Shijiazhuang and Nanjing it is coal, and in Tianjin, Shanghai and Ningbo the primary sources are dust, motor vehicles, and industrial production.

China's investment-driven, energy- and resources-heavy growth model means the biggest pollution sources are electricity generation and the production of industrial materials (cement, steel, chemicals, metals and other resources). Power generation, building materials (mainly cement) and steel production are the top three emitters of several key pollutants, including sulfur dioxide (SO_2) as well as nitric oxide and nitrogen dioxide (NO_x), and dust.

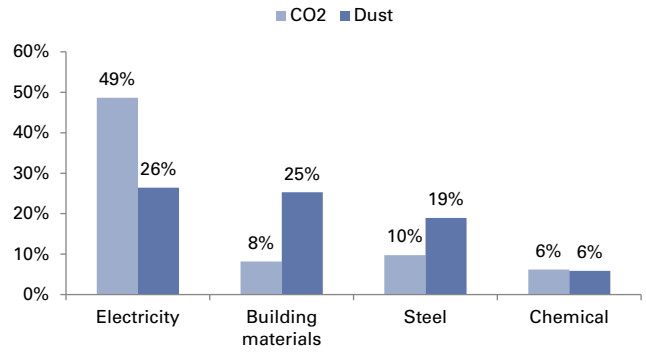
In 2013, China's total SO_2 emission amounted to 16.89mn tons, of which power generation, steel and cement production contributed 43%, 14% and 12%, respectively. China's total NO_x emissions amounted to 14.7mn tons in 2013, of which power generation, building materials and steel production contributed 61%, 19% and 7%, respectively. In the same year, power generation, building materials and steel production accounted for 70% of China's total dust emissions.

Exhibit 46: China's electricity industry is the biggest discharger of NO_X and SO_2 (2013)…



Source: China Statistical Yearbook on the Environment.

Exhibit 47: …while electricity and building materials are the main source for CO_2 and dust (2013)



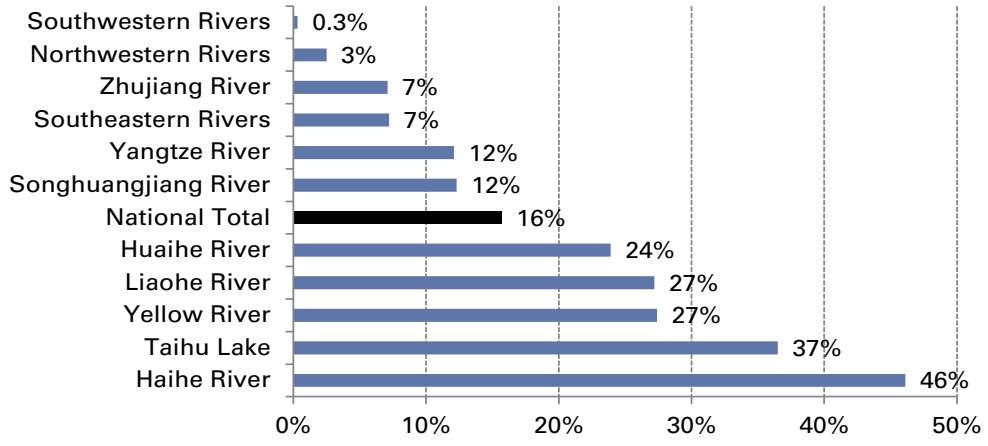
Source: China Statistical Yearbook on the Environment.

Water pollution: Grading and regions most affected

To classify the level of water pollution, a system of grades (I to V) is used. Water classified as Grade IV-V is considered unfit for human consumption. According to the MLR, 60% of groundwater in China exceeded Grade IV in 2013, and, more worryingly, this figure was up five percentage points from 2011.

As of 2012, 67% of the water resources in in China's key river basins was Grade I-III and 15.7% was worse than Grade V with the Haihe River Basin heavily polluted and the Yellow River, Huaihe River and Liaohe River basins moderately polluted. Eutrophication of lakes and reservoirs remains a serious problem. China began its "three rivers and three lakes" pollution control scheme in 1995 but after a 20-year effort these regions continue to suffer from severe water pollution.

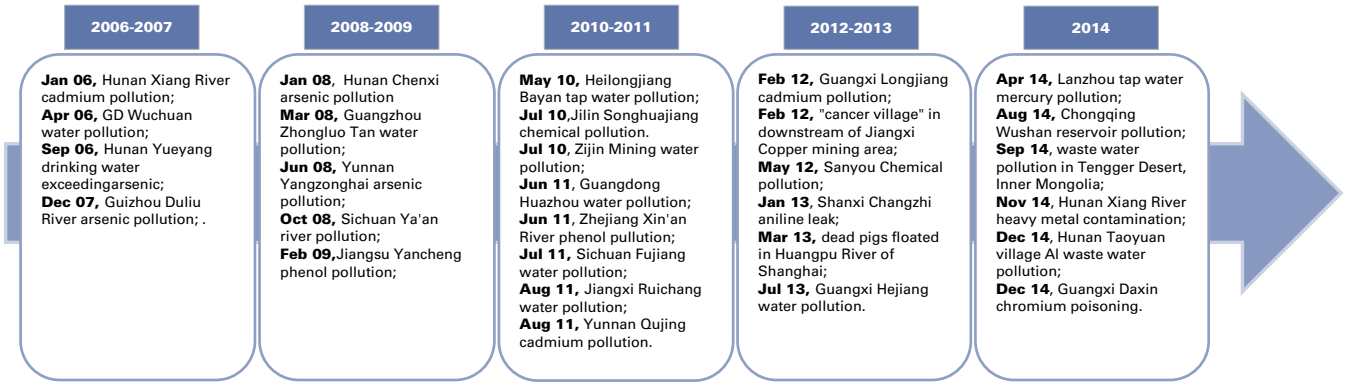
Exhibit 48: Chinese rivers by pollution level
% of evaluated length with worse than Grade V water



Source: China Statistical Yearbook on the Environment, 2013.

As a result of the rapid deterioration in China's water quality, in recent years about half of China's major environmental pollution-related social protests and unrest have been related to water pollution and contamination.

Exhibit 49: Water pollution-related unrest has become a key social instability factor
China's major water pollution incidents

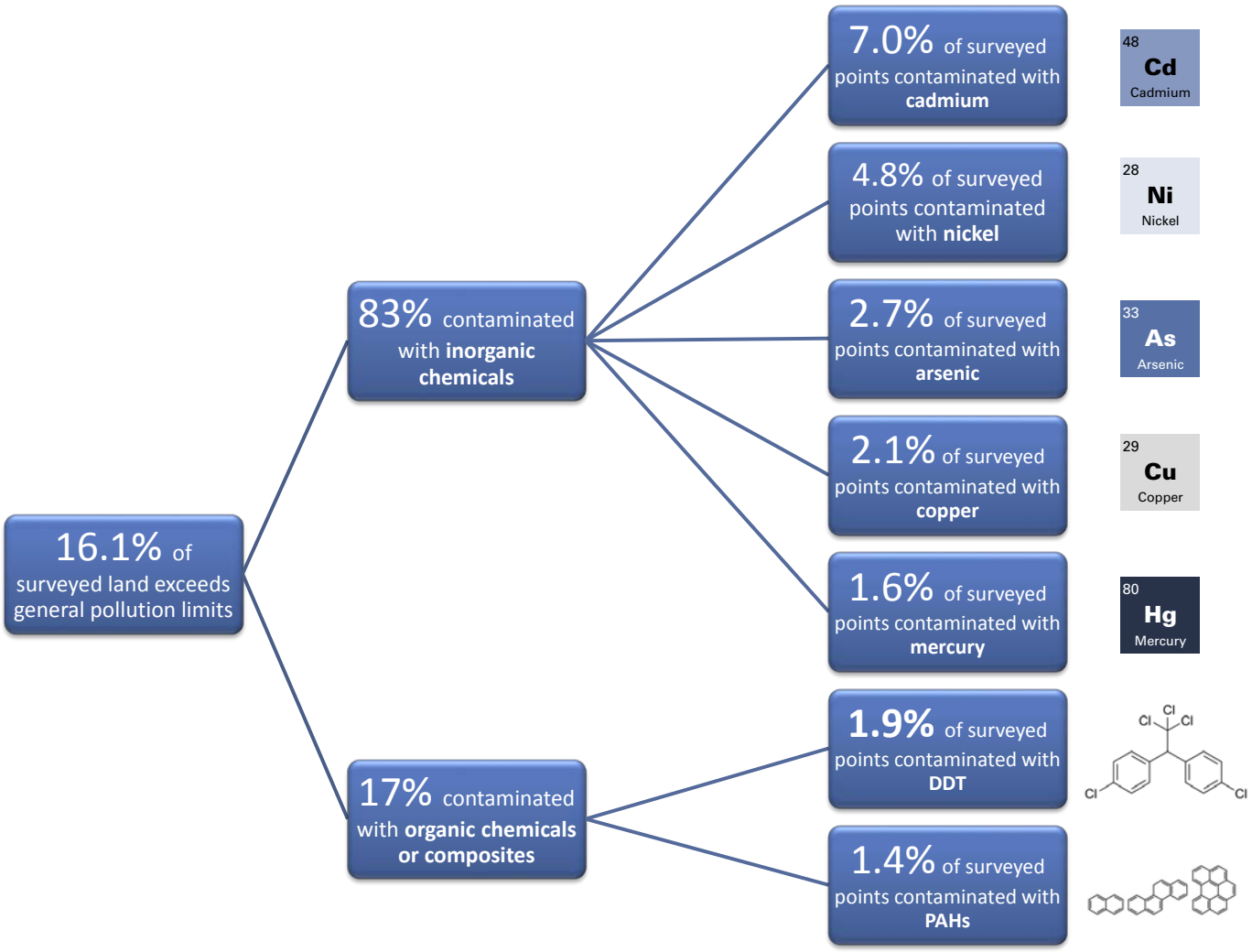


Source: News info complied by Goldman Sachs Global Investment Research.

Soil & solid waste pollution: Problem significantly underestimated

China had no official statistics on soil pollution until April 2014 when part of the results of a national soil pollution survey was released for the first time. That survey, which was conducted by the MEP and the MLR and carried out in 2005-2013, found that 16% of China's soil was polluted beyond acceptable standards, and 19.4% of China's total arable land (65mn out of 334mn acres) was badly contaminated by heavy metals. As the government estimates 300mn acres of arable land is needed to maintain the nation's food security, declaring the 65mn acres of polluted land unfit for food production would push China's total arable land 31mn acres (10% of its total arable land) short of its self-defined "red line" of 300mn acres.

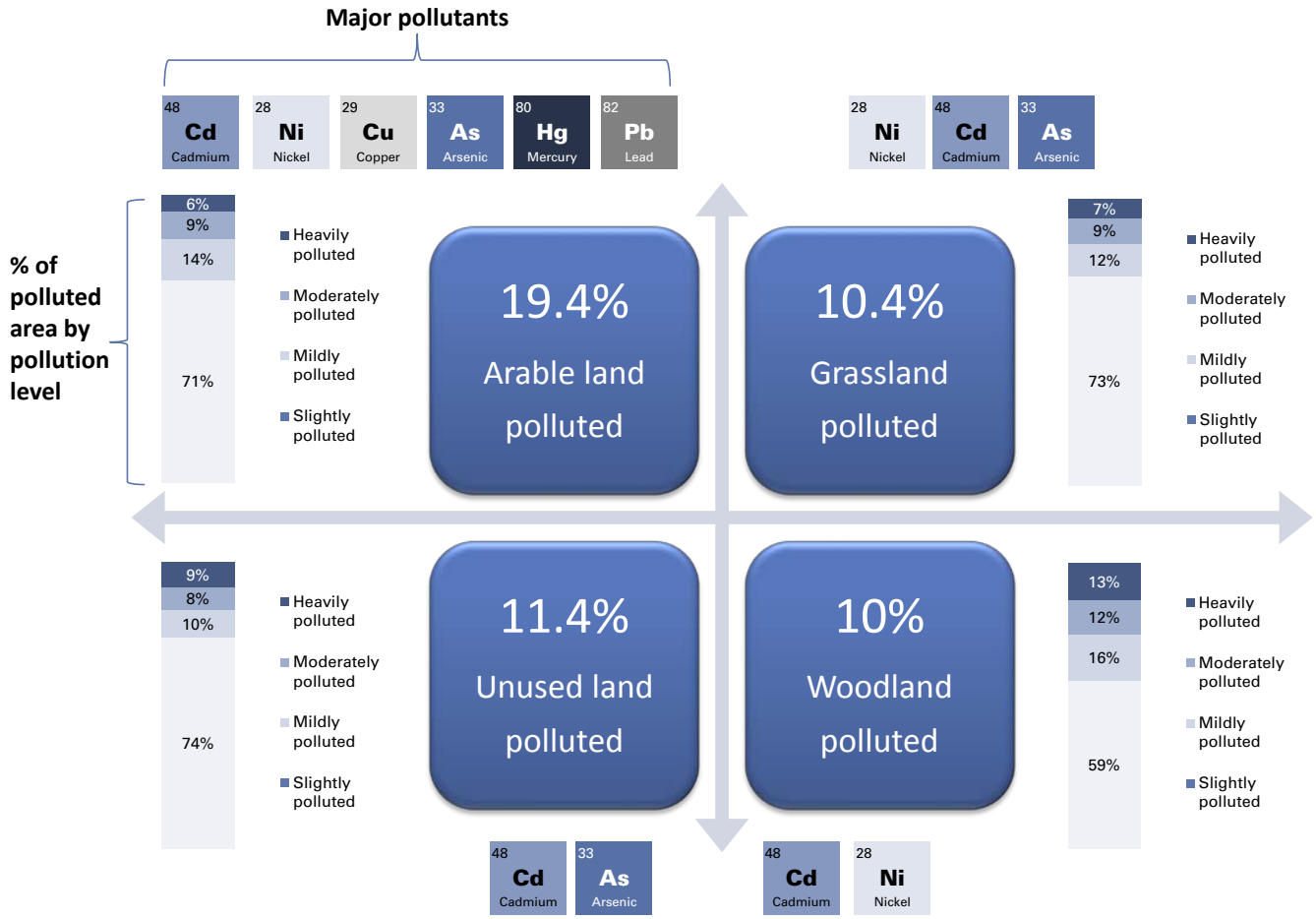
Exhibit 50: How toxic is China's soil?
Heavy metal contamination has threatened China's arable land security's "red line"



Source: The National Soil Pollution Survey released April 17, 2014.

Soil pollution and contamination is more acute in Southern China than in the North due to the heavy concentration of China's metals smelting industry in the South. The Yangtze River Delta, the Pearl River Delta and Northeast China are especially polluted because of their high exposure to heavy industry. Excessive levels of heavy metals are also found in the Southwest and Central South, which are the main regions for metals mining and smelting. The levels of cadmium, mercury, arsenic and lead in the soil increases from the Northwest to the Southeast and from the Northeast to the Southwest.

Exhibit 51: Pollution levels for China's arable land, grassland, woodland and unused land



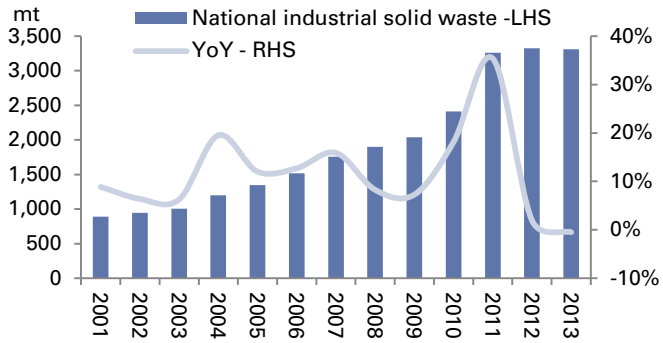
Source: National Soil Pollution Survey published April 17, 2014.

In addition to heavy metal contamination, the surging volume of solid waste has been another key pollution concern for China. Solid waste includes industrial waste, municipal solid waste and waste electrical and electronic equipment (WEEE).

Industrial waste production has been increasing rapidly along with China's strong economic growth over the past 30 years. In 2013, China's industrial solid waste volume amounted to c.3.3 bn tons, representing a 2001-2013 CAGR of 11.4%, according to the China Statistical Yearbook on the Environment, 2014.

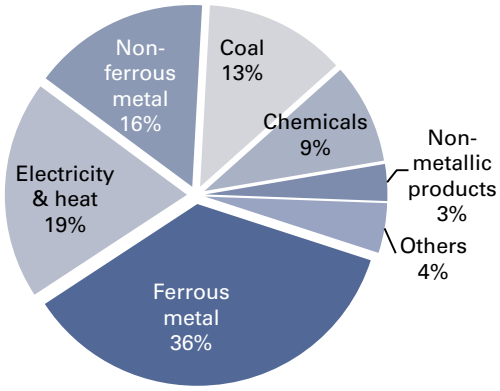
The steel, power generation, metals and mining, coal and chemicals industries are the major producers of industrial solid waste. In 2013, these five industries produced c.2.8 bn tons of industrial solid waste, or 88.7% of the national total.

Exhibit 52: Rapid growth of China's industrial solid waste



Source: China Statistical Yearbook on the Environment, 2014.

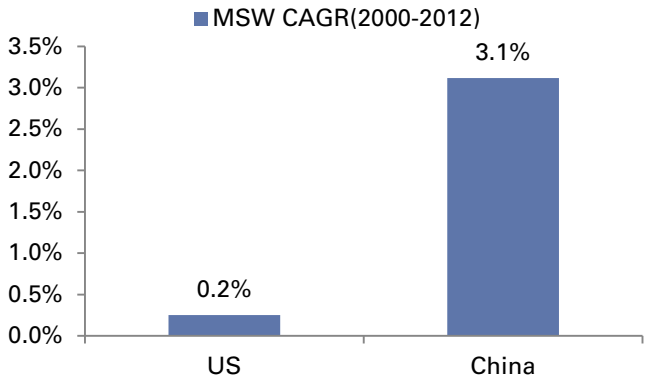
Exhibit 53: Top industrial solid waste producers, 2013



Source: China Statistical Yearbook on the Environment, 2014.

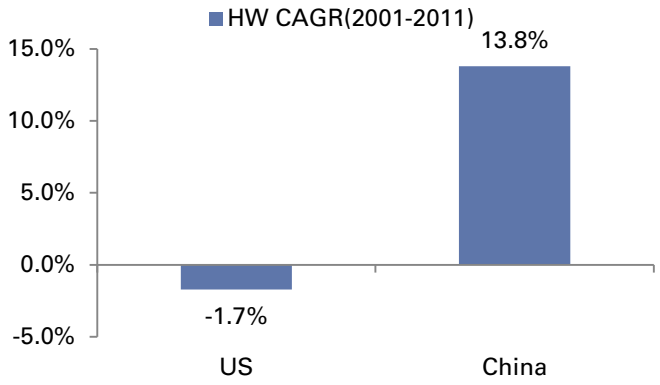
Municipal solid waste has also grown rapidly as a result of the ongoing urbanization efforts. China's urban waste volume increased at a CAGR of 3.1% in 2000-2012 while the US posted an increase of only 0.2% during the same period. China's hazardous waste increased even faster at 13.8% in 2001-2011 vs. a 1.7% decline for the US. With China's further urbanization and its per-capita GDP continuing to grow, we expect China's municipal solid waste to continue to rise rapidly in the next 5-10 years, creating the pressing need for China to invest in the construction of more treatment capacity.

Exhibit 54: Municipal solid waste growth in China vs. US



Source: Ministry of Environmental Protection of China, EPA.

Exhibit 55: Hazardous waste growth in China vs. US



Source: Ministry of Environmental Protection of China, EPA.

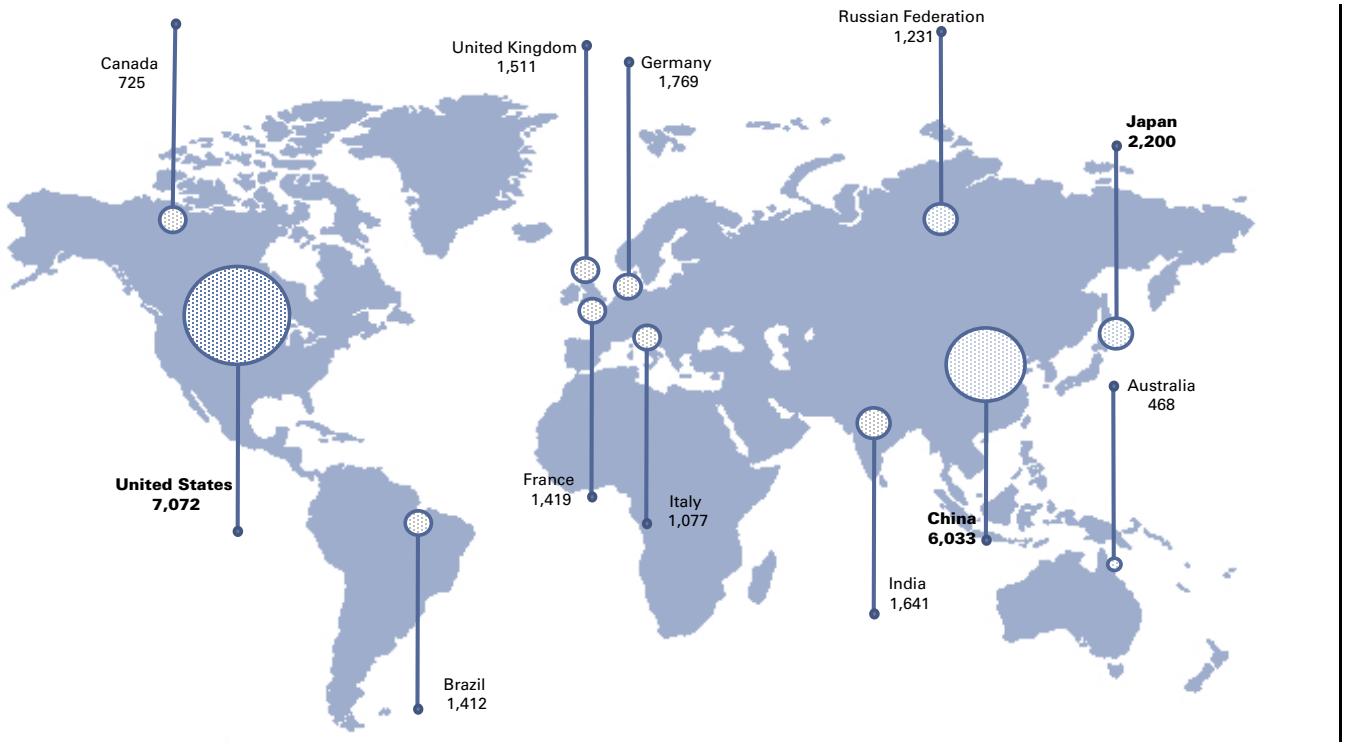
WEEE is an environmental challenge but also the next urban mine

After almost three decades of mass production of electrical and electronic devices and equipment, China has entered a strong "phasing out" period. The tremendous growth of WEEE has become a new and critical challenge to China's already fragile city environment ecosystem, but it also creates new growth potential for the treatment and recycling business.

China is the second-largest generator of WEEE after the US. According to *China's Resources Integrated Utilization Report of 2014*, published by the National Development and Reform Commission (NDRC), China phased out 114.3mn scrap TVs, refrigerators, washing machines, air conditioners and computers in 2013, representing 38.3% yoy growth.

Exhibit 56: 2014 global Waste Electrical and Electronic Equipment (WEEE) generation– China already the second largest producer behind the US

Unit: kt



Source: StEP Initiative, UNU-IAS SCYCLE.

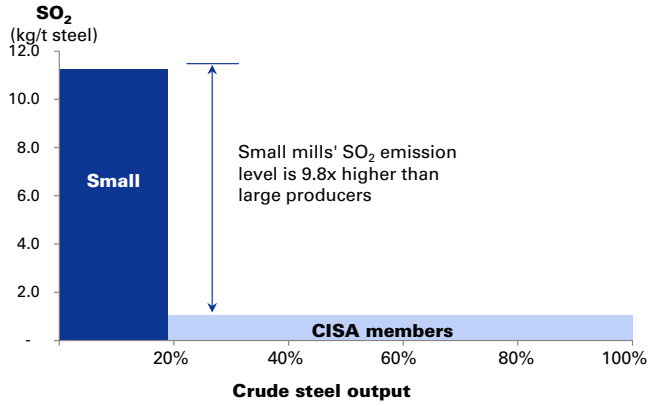
Policy solutions – regulating pollution away

- Eliminating pollution at its source
- Lowering emissions per unit of output
- Increasing clean energy contribution

Eliminating pollution at its source

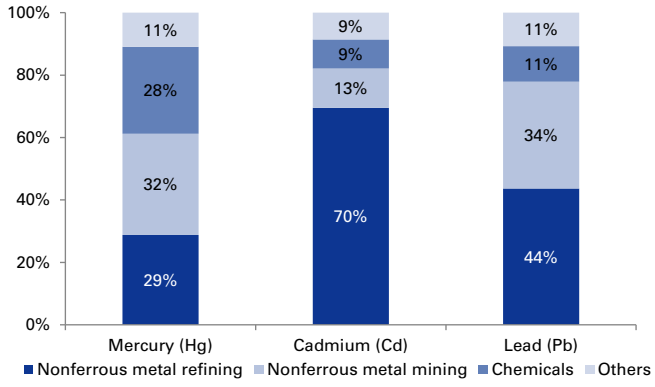
China's metals and mining industry is a major contributor to air pollution, water contamination, dust and soil degradation. Marginal producers have a particularly adverse effect on the environment due to their lack of compliance with environmental regulations. For instance, in 2013, small steel mills produced c.20% of China's total crude steel, but generated 72% of the industry's sulfur dioxide emissions. Aside from air pollution, water contamination has become even more acute due to the fact that environmental regulations were not effectively observed and enforced during the significant capacity expansion in the metals smelting and refining industry over the past decade.

Exhibit 57: Smaller steel mills pollute much more relative to their steel production than larger mills (2013)
In 2013, small steel mills produced c.20% of China's steel but 72% of the industry's SO_2 emissions



Source: MEP, CISA.

Exhibit 58: Nonferrous metals production is a major source of heavy metal pollution in industrial wastewater
Major heavy metal pollutants in industrial wastewater (2013)



Source: MEP.

China introduced its toughest environmental protection policies in September 2013, and the new Environment Protection Law became effective January 1, 2015. This should expedite the permanent closure of more marginal capacity of cement, steel, metals and chemicals, etc., leading us to expect that prolonged industrial resources overcapacity should begin to ease from 2015 onward.

Exhibit 59: Stricter environment protection policies with new cement/steel capacity elimination targets in North China

	Cement				Steel			
mtpa	**Capacity limit by 2017**	*as % of 2014 production*	**Capacity closure**	*as % of 2014 production*	**Capacity limit by 2017**	*as % of 2014 production*	**Capacity closure**	*as % of 2014 production*
Tianjin	5.0	*52%*			20	*87%*		
Hebei			60	*56%*			60	*32%*
Shandong	150	*91%*			50	*78%*	10	*16%*
Shanxi			4	*8%*			6.7	*15%*

No new project approvals for steel, cement, aluminum capacity in Beijing, Tianjin, Hebei and nearby regions

Source: Ministry of Environmental Protection of the People's Republic of China, local government websites, CEIC, NBS.

Stricter emission standards should lead to: 1) a significant increase in capex and opex for marginal commodities producers; and 2) increased and faster exiting of small capacity from supply. This should lead to a higher industry cost curve and a better supply-demand balance, benefiting industry leaders.

Lowering emissions per unit of output

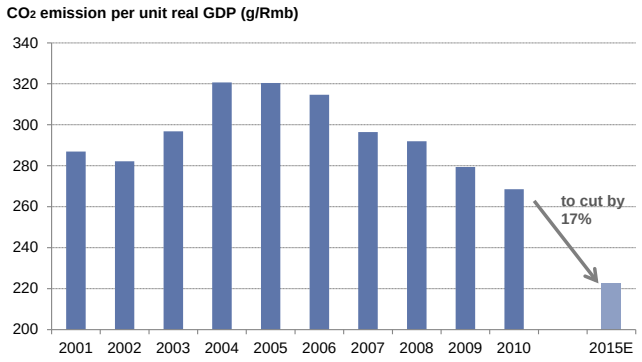
Reducing emissions per unit output

Emission intensity has been gradually declining for coal-fired power plants in China due to: 1) a growing proportion of new/more efficient power plants; 2) still-falling unit coal consumption for coal-fired power generation; and 3) mandated and widespread usage of emission reduction equipment installed at power plants.

In February 20013, The MEP announced stricter emission controls for six pollution-intensive industries covering 47 specific cities in 19 provinces and regions. The MEP will apply such controls to coal-fired power plants as well as the steel, cement, nonferrous metals, petrochemicals and chemicals industries.

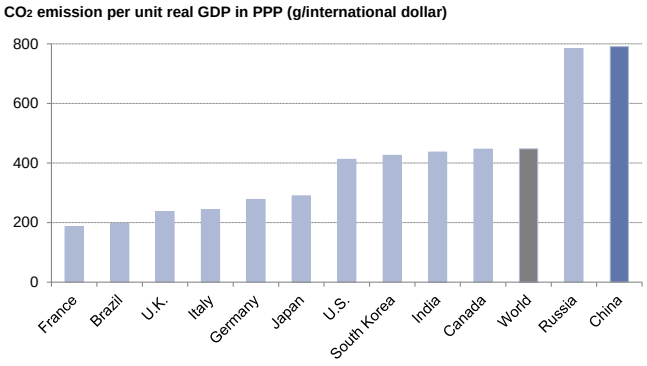
Furthermore, China announced in 2011 its goal to reduce its carbon intensity (CO_2 emission per unit of real GDP) by 17% in 2015 from 2010 levels. As outlined in the 12th Five-Year Plan, China aims to cut 2015 carbon intensity by 17% to around 223g/Rmb, from 269g/Rmb in 2010.

Exhibit 60: China's CO_2 emission intensity has been declining since 2005, and is set to decline more



Source: IEA, State Council, World Bank, Goldman Sachs Global Investment Research.

Exhibit 61: Carbon intensity: China vs. other nations (2010)



Source: IEA, World Bank.

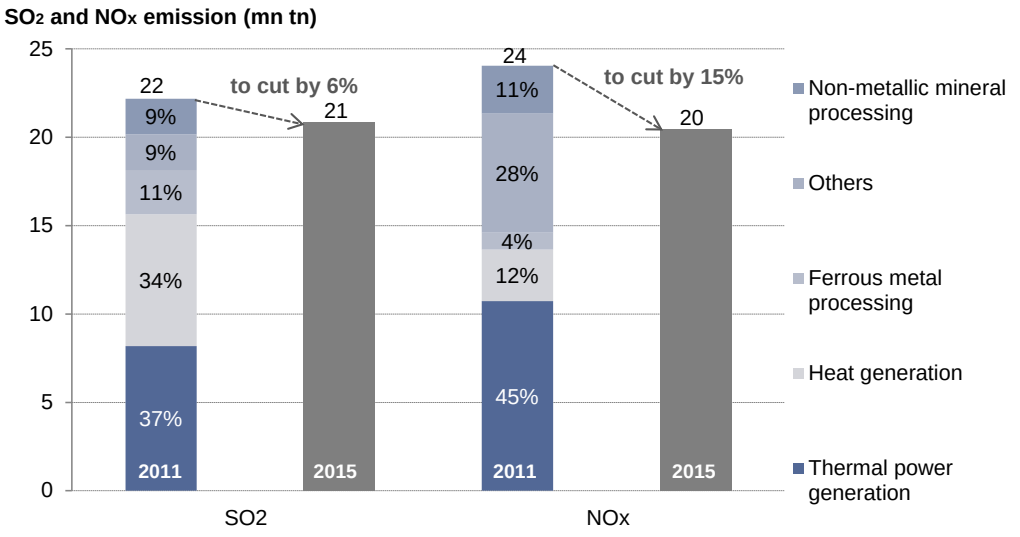
As part of its anti-pollution efforts, China has also installed stricter standards for SO_X and NO_X emissions. The implementation of these higher standards means that smaller players will need to increase investment to comply with the regulations and thereby incur higher operating costs, leading to further competitive costs differentiations between big and small players.

Under the emissions reduction plans, China aims to achieve the following targets in 2015:

Atmospheric emissions: To reduce emissions of CO_2 by 3.1%, chemical oxygen demand (COD) and ammonia nitrogen (NH) by 2%, and SO_2 and NO_X by 3% and 5% from their respective levels in 2014 (Premier Li Keqiang – 2015 Government Work Report).

Under the emissions reduction plan announced in September 2013, China aims to cut total SO_2 and NO_X emissions in 2015 by 6% and 15% from 2011 levels.

Exhibit 62: China to aggressively cut emissions of SO_2 and NO_X



Source: MEP, CEIC.

Wastewater: Achieve treatment ratios of 85%/70% in cities/counties; to add 159k km of pipeline and 45.69mn t/d of wastewater treatment (WWT) capacity; to upgrade 26.11 mt/d of WWT capacity (12th Five-Year Plan for Urban Sewage Treatment and Reclamation Facilities).

Solid waste: Achieve a municipal waste innocuous treatment ratio of 80% by 2015 and 100% treatment ratios for direct-controlled municipalities, provincial capitals and independent planning cities (Note on Improving City Living Waste Processing).

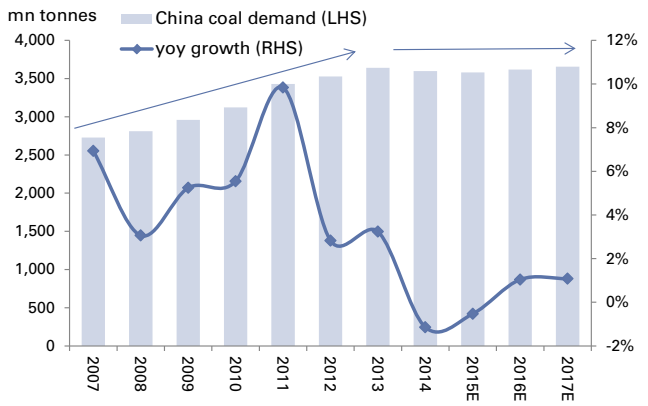
Increasing clean energy contribution

Less fossil (dirty) energy, more non-fossil (clean) energy

Given that coal consumption is the single-largest contributor to China's air pollution, in 2013 the government announced a cap on coal consumption of less than 65% of the total primary energy consumption mix by 2017, down from 67% in 2012. The total annual coal consumption in China's most developed regions (Beijing-Tianjin-Hebei area, Yangtze River Delta and the Pearl River Delta) should decrease before 2016 by sourcing more electricity from other regions, increasing the use of natural gas, etc. Effective September 2013, for any new industrial projects in those regions, no new captive coal-fired power plants are allowed. Specific announced coal consumption caps include mandated reductions from 2012 by 2017 in Beijing (13mt), Tianjin (10mt), Hebei (40mt) and Shandong (20mt).

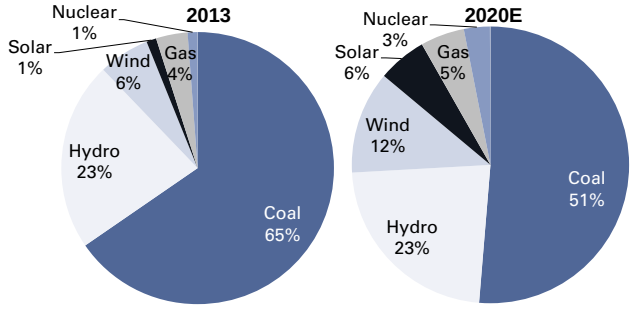
China has also announced increased investments in nuclear power, hydro, wind, solar and biofuel. Non-fossil energy consumption should rise to 14% of China's total annual energy consumption in 2017 from 9% in 2012, according to our China Energy Research Team's estimates.

Exhibit 63: Weaker for longer: China coal demand growth



Source: SXCoal, NBS, Goldman Sachs Global Investment Research.

Exhibit 64: China energy structure: 2013 vs. 2020E
% power generation installed capacity by energy source



Source: China Electricity Council, Goldman Sachs Global Investment Research.

To address its reliance on coal-fired power generation (the single-largest source of pollution), China has begun to diversify its source of energy by promoting the use of clean energy including hydro, nuclear, wind and solar, etc. On the other hand, falling equipment costs (thanks to manufacturing scale), subsidies and technology have improved the relative economics of clean energy, solar in particular.

Our China Energy Research Team forecasts the share of coal-fired power generation will drop to 62% of total power generation in 2020 from 79% in 2010. During the same period, our team expects power generation from wind, nuclear and solar to grow multiple times.

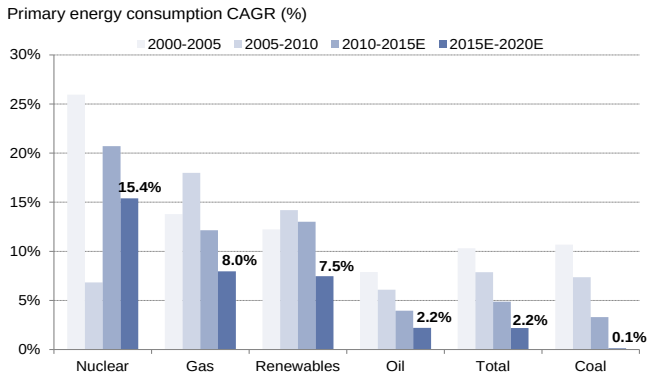
Exhibit 65: We expect non-coal energy to grow from 21% of total power generation in 2010 to 38% in 2020
China's installed power capacity mix (2010 and 2020E)

		Coal	Hydro	Wind	Natural gas	Nuclear	Solar	Others
2010	Total generation capacity	683GW	216GW	30GW	26GW	11GW	Insignificant amount	Insignificant amount
	% of capacity	71%	22%	3%	3%	1%	Insignificant amount	Insignificant amount
966GW	% of power generation	79%	17%	1%	2%	2%	Insignificant amount	Insignificant amount
2010-2015E generation capacity CAGR (%)		5%	8%	32%	18%	23%	N/M	N/M
2015E	Total generation capacity	882GW	311GW	118GW	60GW	30GW	40GW	Insignificant amount
	% of capacity	61%	22%	8%	4%	2%	3%	Insignificant amount
1,440GW	% of power generation	69%	19%	4%	4%	3%	1%	Insignificant amount
2015E-2020E generation capacity CAGR (%)		0%	5%	12%	9%	12%	20%	N/M
2020E	Total generation capacity	900GW	400GW	210GW	90GW	53GW	100GW	Insignificant amount
	% of capacity	51%	23%	12%	5%	3%	6%	Insignificant amount
1,754GW	% of power generation	62%	19%	6%	5%	6%	2%	Insignificant amount

Source: China Electricity Council, Goldman Sachs Global Investment Research.

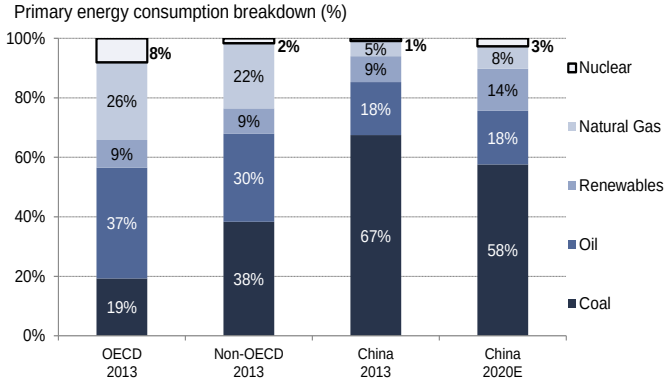
Nuclear: Our China Energy Analyst, Franklin Chow, expects China's nuclear power generation to grow at a 2015-2020 CAGR of 15%. By 2020, he estimates that nuclear, as the fastest-growing primary energy, will contribute 3% of total primary energy consumption in China, up from 1% in 2013. China now has 23 operating nuclear power plants, ranked sixth globally in terms of installed capacity (as of June 30, 2014). According to the China Nuclear Energy Association (CNEA), China has 37 nuclear power plants under construction, ranked first globally in terms of capacity under construction (as of June 30, 2014.).

Exhibit 66: Nuclear to be the fastest-growing primary energy source in China
Primary energy consumption CAGR (%), 5-year periods over 2000-2020E, China



Source: BP Statistical Review, CEC, National Bureau of Statistics (NBS), NEA, Goldman Sachs Global Investment Research.

Exhibit 67: Changing energy mix – China vs. OECD
Primary energy consumption breakdown, OECD, non-OECD, China, 2013, and 2020E



Source: BP Statistical Review, CEC, NBS, National Development and Reform Commission (NDRC), NEA, Goldman Sachs Global Investment Research.

Wind: Our China New Energy Analyst, Frank He, estimates China will grow its cumulative wind installed capacity seven-fold to 210GW in 2020 from 30GW in 2010. This significant investment in upgrading China's existing transmission network and building ultra-high voltage transmission lines should facilitate the rapid expansion of China's wind power industry.

Solar: Our China Energy Research Team expects China will continuously lead global solar installation in 2015, maintaining over 10GW of annual installation. Our Energy team forecasts China will grow its total solar installation to 100GW by 2020E, or 6% of total energy generation capacity. Our team also believes that, driven by lower power generation costs and supportive policies, solar power is reaching "grid parity" in the EU, the US, China and Japan.

Monetization – charging pollution away

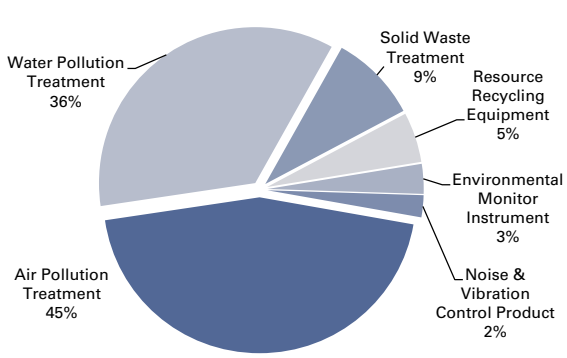
- Solid waste: Huge upside as little captured yet
- Water savings and treatment: Higher tariffs needed
- Air pollution: Emission trading a trillion dollar market
- Introducing more diversified funding approaches

Solid waste: Huge upside as little captured yet

According to the MEP's 2011 Report on the National Environmental Protection Industry, China's solid waste treatment market was valued at about Rmb18.2 bn, accounting for only 9% of overall environmental protection industry revenue. In the US, however, revenues from solid waste management amounted to US$40.7 bn in 2012, accounting for 37% of revenues for the US's environmental protection industry.

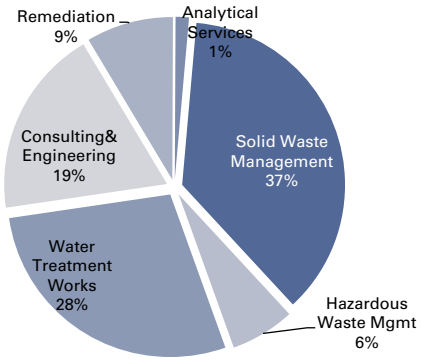
As the vast majority of China's solid waste goes untreated, we believe China's solid waste treatment industry is significantly underestimated. Now that the country has begun to implement new regulations and laws covering solid waste treatment and is likely to announce the Soil Ten regulation (Action Plan of Soil Pollution Prevention) soon, we see huge growth potential.

Exhibit 68: China's solid waste treatment accounted for 9% of EP services in 2011



Source: 2011 China Environment Protection Related Industry Report.

Exhibit 69: US solid waste management accounted for 37% of EP services in 2012



Source: US Department of Commerce.

China needs significantly higher prices for solid waste treatment. In 2013, China's GDP per-capita reached US$6,800, placing it among the upper mid-income countries. However, China's solid waste treatment charges are sharply below those in countries with similar income levels. For instance, China's unit landfill charge is ~Rmb75/ton (US$12/ton) vs. US$25-65/ton for upper mid-income countries. The tariff of waste to energy (WtE) is around Rmb250/ton in China (summing up the Rmb80/ton treatment fee and electricity sales at Rmb0.65/KWh per 280KWh/ton), vs. the US$60-US$150/ton level in the upper mid-income countries.

Exhibit 70: Waste treatment fee across different income levels

	Low Income countries	Lower Mid Income countries	Upper Mid Income countries	High Income countries
Income (GNI/capita)	<US$876	US$876-3465	US$3466-10725	>US$10725
Waste generation (ton/capita/yr)	0.22	0.29	0.42	0.78
Collection efficiency (percentage collected)	43%	68%	85%	98%
cost of collection and disposal(US$/t)				
Collection	20-50	30-75	40-90	85-250
Sanitary landfill	10-30	15-40	25-65	40-100
Open dumping	2-8	3-10	NA	NA
Composting	5-30	10-40	20-75	35-90
Waste-to-Energy	NA	40-100	60-150	70-200
Anaerobic Digestion	NA	20-80	50-100	65-150

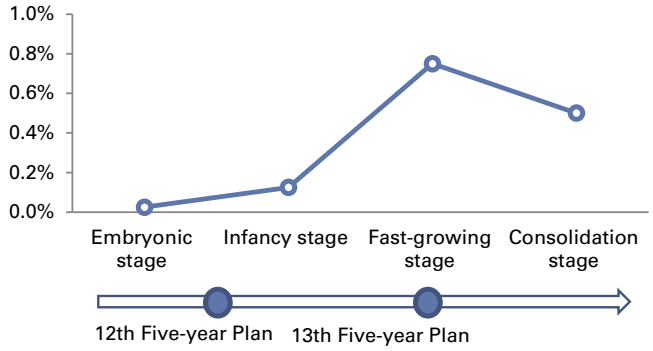
Source: World Energy Council.

China WtE a Rmb100bn market by 2020. In 2014, China's urban waste collection volume totaled 173mn tons, and we forecast the market to grow at a 3% CAGR to 200mn tons by 2020. Assuming a WtE tariff in line with the global average of US$100/ton and a WtE treatment ratio of 85%, we estimate a Rmb104.2 bn market size by 2020, representing a CAGR of 24%.

Much work also to be done on soil remediation. The soil remediation industry in the US has gone through four stages: 1) embryonic stage (1980s); 2) infancy stage (1993-2001); fast-growing stage (2001-2004); and 4) consolidation stage (2005 to present).

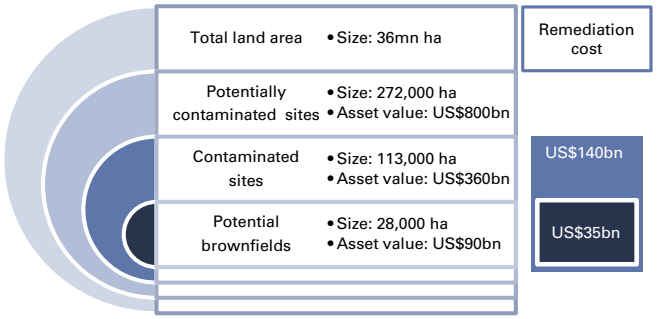
China's soil remediation industry is still in the embryonic stage, but the technological foundation needed for future growth has been put in place over the past five years. China's land area is 27 times larger than Japan's, whose current market is valued at ¥200 bn-¥300 bn p.a. (about Rmb10 bn-Rmb15 bn). We estimate the output of China's soil remediation industry to reach Rmb685 bn in 2016-2020, representing 585% growth compared to 2011-2015. The State Council is now reviewing the Soil Ten (Action Plan of Soil Pollution Prevention). When the plan is announced, we expect the development of China's soil and underground water remediation industry will benefit significantly and be positioned to develop into a subsector worth of hundreds of billions of renminbi.

Exhibit 71: Soil remediation in US: Four stages
Soil remediation investment/GDP by year



Source: Shanghai IE Expo conference materials.

Exhibit 72: Brownfield problems in Japan (2003)



Note: "Brownfield site" refers to real estate that may be difficult to expand, redevelop or reuse due to the presence or potential presence of a hazardous substance, pollutant, or contaminant.

Source: 2003 survey from Soil Environment Management Division of Environmental Management Bureau of MoE Government of Japan.

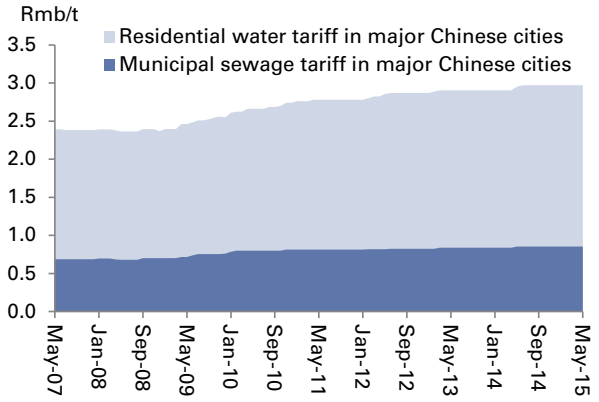
Water savings and treatment: Higher tariffs needed

Prices rationalization and discovery suggests further market upside

One key reason for China's chronic and deteriorating environmental system is its chronic low pricing of utilities, from water supply to water treatment, from farming land use rights to resources taxes, and its very low CO_2 and NOx emission charges. Cleaning up pollution across the ecosystem will require a rationalization of utilities prices, meaning users and polluters will need to pay more realistic costs so that suppliers of pollution reduction services are appropriately incentivized to provide good environmental protection and improvement services. Such utilities prices rationalization and discovery imply tremendous opportunities for environmental improvement solutions providers to grow and monetize.

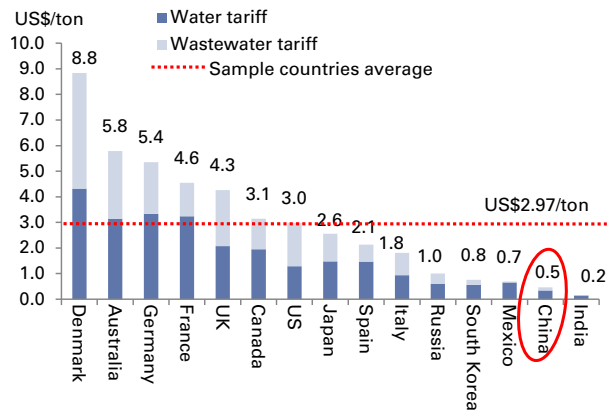
One key example of price rationalization and discovery would be water tariff and wastewater treatment charges. Although China's average water resources per capita amounts to only 25% of the global average (according to the UN's 2008 survey), and China has been raising water tariffs for the past decade, water prices in Chinese major cities are still significantly below the global averages. China's average water and wastewater treatment tariff is only around 17% of the global average (2013).

Exhibit 73: China's wastewater tariff



Source: H20-China.

Exhibit 74: China's water tariffs are much lower than those in developed countries (2011)



Source: Global Water Intelligence (GWI), 2011 survey.

We believe China's artificially low water tariffs are likely to increase soon. In January 2015, the NDRC set the following targets to be achieved by 2016:

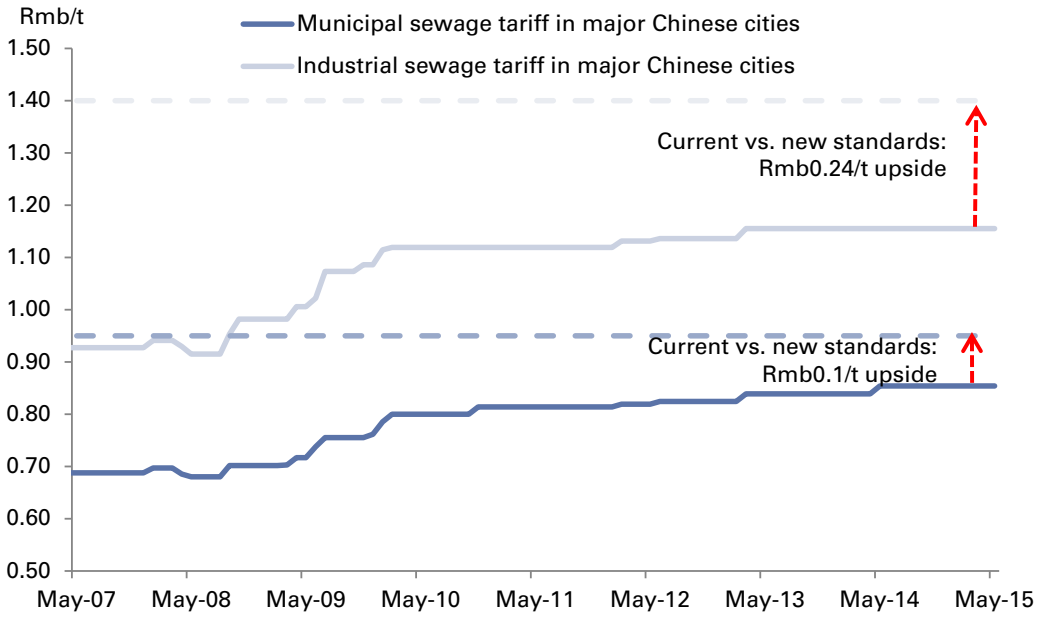
1. Urban wastewater treatment (WWT) tariff to be no less than Rmb0.95/ton for residential use and Rmb1.40/ton for non-residential use.
2. Major counties' WWT tariff to be no less than Rmb0.85/ton for residential use and Rmb1.20/ton for non-residential use.

If the local tariff already meets the above standard but is still not high enough to compensate for operators' costs, we think WWT tariff should be further raised to warrant acceptable profitability for WWT service providers.

For areas where a WWT tariff is not established, the NDRC advocates collection by 2015 and the construction of a WWT plant within the following three years.

According to H2O-China, China's current average residential wastewater tariff and industrial wastewater tariff are Rmb0.85/ton and Rmb1.16/ton, respectively, for the 20 largest cities, which are 10% and 17% below the new standards. Hence, we believe the WWT tariff faces further upside.

Exhibit 75: Current residential and industrial WWT tariffs are 10%/17% below new standard
China's municipal and industrial sewage tariff in the 20 major cities vs. new standard



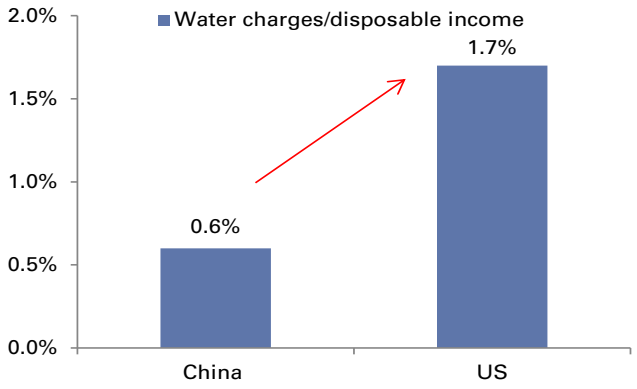
Source: H20-China, Goldman Sachs Global Investment Research.

What China can do

China's current water tariff is too low, in our view. In 2013, China's per-capita water consumption was 55.3 cubic meters while its per-capita water tariff was Rmb156 based on the Rmb2.83/ton average water tariff in 28 major cities. This suggests that China's water tariff is only around 0.6% of the average disposable income, sharply below the 1.7% in the US and the 2.5%-3% suggested by the *Study on the Urban and Rural Water Shortage Problem* released by China's Ministry of Housing and Construction.

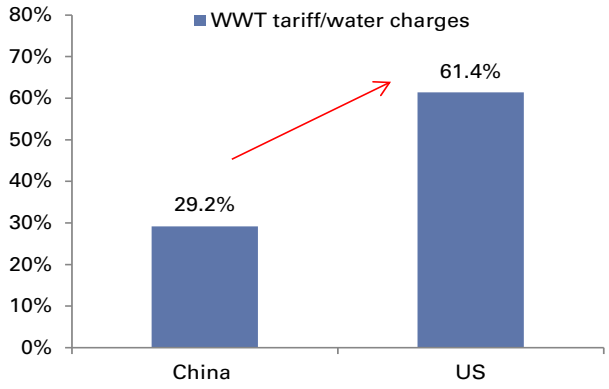
WWT tariff has significant upside. WWT facilities require significant investment. The WWT tariff accounted for 61.4% of the overall water tariff in the US in 2013. By comparison, China's average WWT tariff is Rmb0.85/ton, less than 30% of its overall water tariff. In order to further increase China's WWT ratio, a much higher WWT tariff is a prerequisite.

Exhibit 76: Water tariff as a percentage of per-capita personal disposable income in 2013



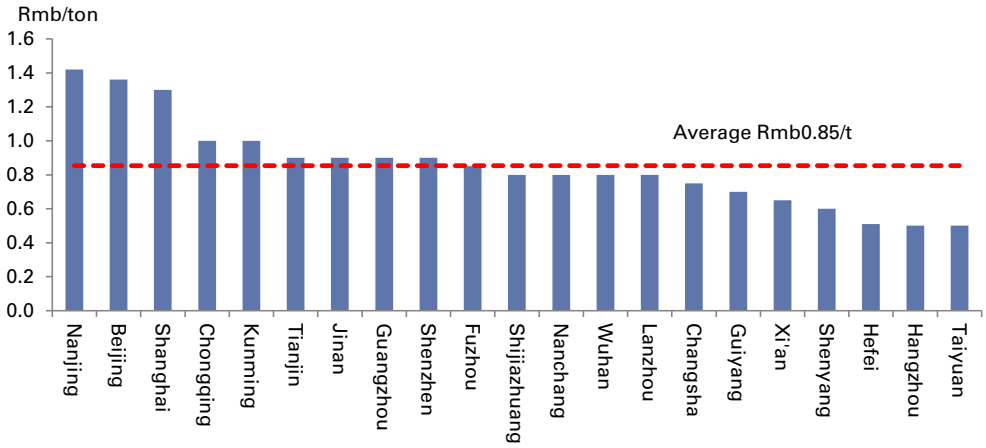
Source: MEP, EPA.

Exhibit 77: WWT tariff accounts for only 29.2% of total water charges in China vs. 61.4% in the US in 2013



Source: MEP, EPA.

Exhibit 78: WWT tariff in major Chinese cities in 2013



Source: H2O-China.

We believe water tariff reform should stimulate a huge investment opportunity, and the WWT market offers even more attractive opportunities. We estimate China's ongoing water tariff reform will add Rmb136 bn of upside to the current market for the WWT industry. Our estimate is based on the following assumptions:

1. Total water tariff would account for 1.5% of disposable income.
2. WWT tariff ~50% of total water price, resulting in Rmb3.66/ton based on 2013 disposable income and water consumption.

Exhibit 79: China's WWT: We see Rmb136 bn upside for the WWT market

	Unit	Calculation	
Per capita disposable income (2013)	Rmb		27,000
		x	1.5%
Per capita water charges	**Rmb**	**=**	**405**
Per capita water consumption	ton	/	55.3
Implied unit water tariff	**Rmb/ton**	**=**	**7.32**
WWT tariff as % of total water tariff	%	x	50%
Implied WWT tariff	**Rmb/ton**	**=**	**3.66**
Current WWT tariff	Rmb/ton	—	0.85
Upside to WWT tariff		**=**	**2.81**
Wastewater treatment volume (2013)	bn ton		48.5
Upside to current WWT market	**Rmb bn**		**136**

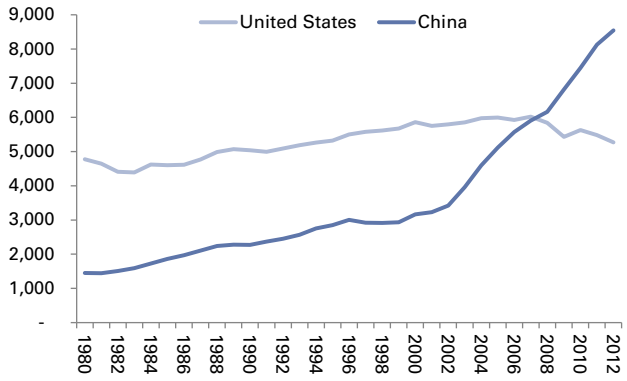
Source: Wind, CEIC, Goldman Sachs Global Investment Research.

Air pollution: Emission trading a trillion dollar market

Global warming has attracted huge attention and raised serious concerns world-wide. The United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature on May 22, 1992, and countries that are signatories to the convention continue to meet annually to review the progress made toward implementing their targets. In 1997, the Kyoto Protocol was adopted, and the EU promised to reduce greenhouse gas emissions 20% by 2020 from its 1990 levels.

The US and China together released a Joint Announcement on Climate Change in 2014, in which the US promised to reduce CO_2 by 26%-28% from its 2005 level by 2025, and China agreed to reach a CO_2 emission peak before 2030. As per the pledge made by China as part of the UNFCCC and the Kyoto Protocol, China has announced plans to cut its CO_2 emissions by 40%-50% in 2005-2020.

Exhibit 80: CO_2 emissions: US vs. China
mt



Source: EIA.

Exhibit 81: Emission targets for major countries

Country	Target	Base year	Target year
China	Peak emission around 2030	NA	2030
US	Cut emission by 26%-28%	2005	2025
Russia	Cut its emission 25%-30%	1990	2030
Switzerland	Cut emission by 50%	1990	2030
Japan	Cut emission by 20%	2005	2030
UK	Cut emission by 80%	1990	2020
EU	Cut greenhouse gas emissions by 20%	1990	2020

Source: Media reports compiled by Goldman Sachs Global Investment Research.

CO_2 Emission Trading Scheme in the EU and US

The Emission Trading Scheme (ETS) in the EU was launched in 2005 as the world's first international company-level "cap-and trade" system to reduce CO_2 emissions in a cost-effective way. When the program was launched in 2005, 321mnt CO_2 was traded for a total consideration of US$7.9 bn. By 2011, this market had grown significantly to 7.9bn tons for a total consideration of US$147.9 bn in 2011.

Exhibit 82: EU Emission Trading Scheme summary

		EUA	P-CER	S-CER	ERU	Sum
Trading volume (mn tons)	2012	7,903	339	1,686	715	10,642
	2013	8,651	264	445	899	10,259
Trading value (US$ mn)	2012	77,016	1,120	5,878	1,456	85,479
	2013	52,348	149	251	102	52,849

Note: EUA = European Union Allowance ; P-CER = Primary Certified emission reduction units; S-CER = Secondary Certified emission reduction units; ERU =. Emission Reduction Unit

Source: Bloomberg New Energy Finance.

US greenhouse gas emission schemes include the Regional Greenhouse Gas Initiative (RGGI), the Western Climate Initiative (WCI) and the Chicago Climate Exchange (CCX). The RGGI is the first mandatory market-oriented scheme designed to reduce the overall volume of greenhouse gas emissions. It targets a 10% reduction in US greenhouse gas emissions in 2009-2018. The WCI aims to reduce emissions by 15% in 2005-2020. Different from the above two schemes, the CCX is a voluntary program, and members enrolled in the CCX have to make voluntary but legally binding promises.

Exhibit 83: Comparison of ETS in California, EU-ETS, and Quebec

	California's GHG cap-and-trade program	EU's Emissions Trading System	Quebec's Carbon Market
Population (mn)	38	500	8
Gross Regional Product (US$tn)	1.9	16	0.3
Participating Jurisdictions	California	30 nations	Quebec
Greenhouse Gases Covered	CO_2, NO_2, CH_4, PFCs, SF_6,NF_3, other fluorinated greenhouse gases	CO_2, NO_2, SF_6, and PFCs starting in 2013	CO_2, CH_4, NO_2, SF_6, PFCs, NF_3, other fluorinated greenhouse gases
Sectors Covered	Power and industrials in 2013; plus ground transportation and heating fuels in 2015	Power, heat and steam production, and oil, iron and steel, cement, glass, pulp and paper 2005-2012; plus CO_2 from petrochemicals, ammonia, aviation and aluminum, NO_2 from acid production, and PFCs from aluminum starting in 2013	Power and industrials in 2013; plus ground transportation and heating fuels in 2015
Target	17% below 2013 emissions by 2020	21% below 2005 levels by 2020	20% below 1990 levels by 2020.
2013 Allowance Budgets (mt)	163	2,039	24
Emissions Target (mt)	334 (2020)	1,643 (2020)	51 (2020)

Note: GHG = Greenhouse gas.

Source: the Center for Climate and Energy Solutions (C2ES).

China's carbon trading likely to be a Rmb100 bn market by 2020

China's rapid economic development and coal-oriented energy consumption structure has significantly increased its CO_2 emissions. In 2013, China's CO_2 emissions reached 10bn tons, even greater than CO_2 emissions in the US (5.35bn tons) and the EU (3.5bn tons) combined.

As per the pledge made by China as part of the UNFCCC and the Kyoto Protocol, China has announced plans to cut its CO_2 emissions by 40%-50% in 2005-2020.

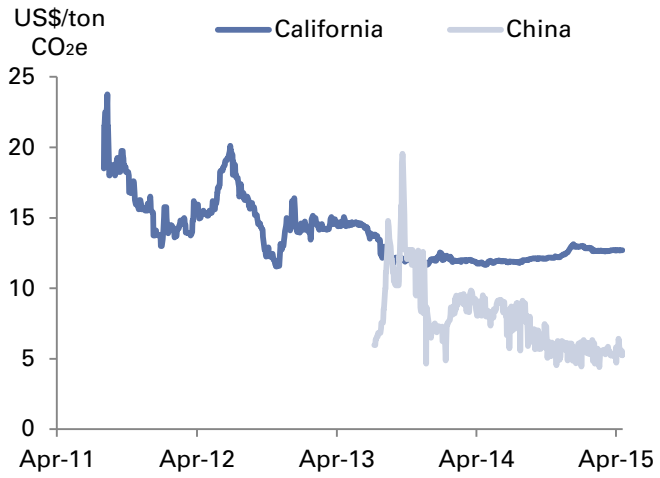
The State Council issued its 12th Five-Year Work Plan on Greenhouse Gas Emission Control at end-2011, and it initiated the idea of establishing a carbon trading market. In October 2011, Pilot programs were approved in Beijing, Tianjin, Shanghai, Chongqing, Hubei, Guangdong and Shenzhen. By 2014, all approved schemes had been launched, covering 1,919 companies with total allocated volume of 1.2bn tons. In November 2014, the NDRC unveiled National Carbon Trading Implementation Rules. By November 2014, accumulated trading value was Rmb500 mn with 13.75mn tons traded at an average price of Rmb36.4/ton.

Exhibit 84: Scope and scale of each carbon trading pilot in China (2014)

Region	Market size (bn tons allowance)	Coverage	Emission% covered
Guangdong	0.39	Power, cement, steel, petrochemical	58%
Hubei	0.32	Power, cement, chemical, metals, autos, paper, steel, petrochemical	40%
Shanghai	0.14	Power, cement, chemical, metals, autos, paper, steel, petrochemical, construction materials, ruber, aviation, airport, hotel	50%
Beijing	0.06	Power, steam, manufacturing, public facilities	40%
Tianjin	0.11	Power, steam, cement, steel, petrochemical, refinery, commerial property	60%
Chongqing	0.03	Electrolytic aluminum, cement, steel, calcium carbide, caustic soda	n.a.
Shenzhen	0.03	Power, industry, property	38%

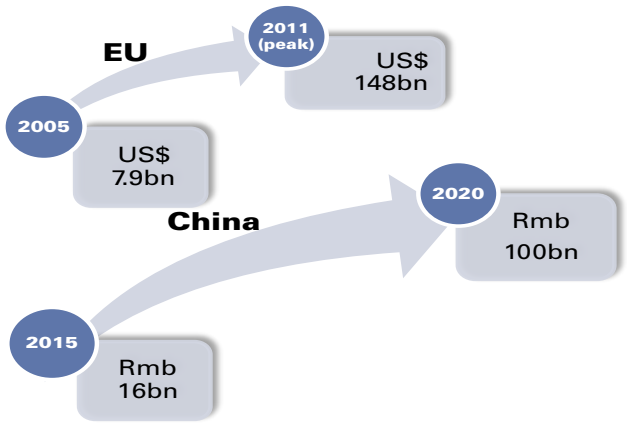
Source: Media reports compiled by Goldman Sachs Global Investment Research.

Exhibit 85: CO_2 trading prices comparison



Source: California Carbon Dashboard.

Exhibit 86: CO_2 trading value potential: China vs. EU



Source: Shanghai IE Expo conference materials.

At the 2015 China Carbon Forum, Mr. Jiang Zhaoli, director of domestic policy and implementation of the NDRC's Climate Department, said China's Carbon Trading Market will kick off by 2016. The national scheme will cover 5 + 1 industries, power, metallurgy, nonferrous metals, construction materials, chemicals, and aviation, covering enterprises with annual emissions exceeding 26 kt.

We estimate China's total carbon trading amount will reach 3-4bn tons p.a. by 2020, implying a carbon trading market size of Rmb100 bn (based on a CO_2 trading price of Rmb30/t as of May 2015). However, given that China's CO_2 emissions are already almost three times the size of the EU's (10bn tons of trading volume in 2013), we expect significant upside to China's CO_2 trading market over the next decade.

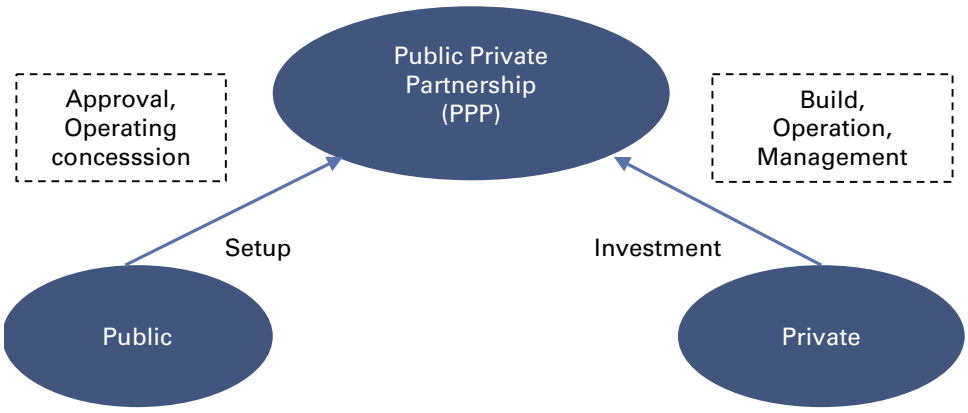
Introducing more diversified funding approaches

As a result of the government's changing role in the environmental cleanup, China has opened up the industry to the private sector to secure enough funding and attract good competition by introducing many initiatives. The Public Private Partnership (PPP) is one of the key milestone initiatives:

- Detailed Guidelines for the Development of Urban Facilities by PPP have been laid out by: 1) Guidance on Encouraging Social Investment with Investment and Financing Mechanism in Key Sectors released by the State Council; and 2) Guidelines on Development of Public–Private Partnership Projects released by the NDRC.
- On April 9, 2015, the MEP and the Ministry of Finance issued a joint statement to promote PPP funding in water treatment.

Public-Private Partnership (PPP) and Third Party Treatment (TPT)

Exhibit 87: Public–Private Partnership (PPP) model



Source: Goldman Sachs Global Investment Research.

In order to improve pollution reduction efficiency and achieve optimal results from investment, China's government has been proactively promoting the Third-Party Treatment (TPT) model, which allows polluters to contract out their pollution to professional third-party pollution control services providers. On the other hand, it also allows the government to better supervise and monitor the progress of pollution reduction efforts.

Exhibit 88: Public Private Partnership (PPP) and Third Party Treatment (TPT)

	Third-party treatment (TPT)	Public-private partnership (PPP)
Business model	Polluters cost saving by adopting professional treatment Regulators cost saving by centralizing monitoring targets Environmental protection market unlocked	Private capital introduction Longer time-horizon Efficiency improvement
Policy support	Tariff hike Fiscal support Capital market	PPP promotion nationwide PPP implementation enforced Launch of a series of policies

Source: Goldman Sachs Global Investment Research.

Further lessons – policy, investments, and more

- Recent policy initiatives
- Lessons from developed economies
- China under-invested, but catching up
- Pollution cleanup: Beijing case study

Recent policy initiatives

Since 2013, a number of key laws, regulations and initiatives have been passed with immediate effect, empowering the MEP to act with force:

September 2013: The Air Pollution Action Plan (Air Ten).

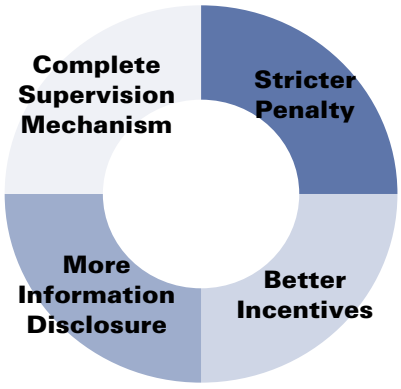
Exhibit 89: Air pollution control action plan

Overall target	To reduce PM10 density by 10% for prefecture level cities and above, and PM2.5 density by 25%/20%/15% for Beijing-Tianjin-Hebei (BTH), Yangtze River Delta (YRD) and Pearl River Delta (PRD), respectively.
	Key measures
1	**Reduce multiple pollutant emission**
	a) Accelerate conversion of coal into gas/electricity. Replacing small coal boilers (<10 tonnes/hour). Target to complete the conversion by 2015 in BTH, YRD and PRD.
	b) Promote public transport system and restrict no. of vehicles in first-tier cities. Full upgrade of gasoline from Euro III to Euro IV by 2013 and diesel from Euro III to Euro IV by 2014. Euro V gasoline shall be in place in BTH, YRD and PRD by 2015 and nationwide by 2017.
	c) Accelerate the rollout of new/clean energy vehicles including gas vehicles. Target to have over 60% of new buses in Beijing, Shanghai and Guangzhou coming from new/clean energy vehicles.
2	Optimize industrial structure, promote upgrade and transformation of overcapacity industris.
3	Accelerate technological upgrade to facilitate environment protection. Promote recycling and energy-saving economy.
4	**Transformation of energy consumption structure**
	a) Aim to lower the weight of coal to below 65% by 2017, which would be replaced by natural gas and non-fossil fuel energy. Coal power plant will no longer be permited.
	b) Increase the supply of natural gas, coal-to-gas and CBM. Develop gas power plant as a buffer for peak season, however no new gas power plant project shall be built in principle. Accelerate the conversion of coal facility to gas for companies in BTH, YRD and PRD.
5	Strictly enforce environmental assessment when planning for the overall industrial development blueprint
6	Bring market mechanism to play and better environmental economy policies
7	Establish a complete legal system and strictly enforce the regulation and management
8	Establish a regional coorperation mechanism and manage the environmental protection in the region from a high level
9	Establish a monitoring and early warning system to tackle highly polluted weather
10	Government should take the leadership and liaise with multiple parties to participate in environmental protection

Source: State Council website.

January 2015: The new Environment Protection Law (effective January 1, 2015) introduced many actionable and measureable rules and targets such as linking environmental protection targets to local government officials' performance assessment and introducing a daily penalty for violation of environmental regulations.

Exhibit 90: Key highlights of the new Environmental Protection Law



1. **Total emission control:** suspend new project approval in over emission regions
2. **Daily penalty** and legal liability
3. **Empower** MEP with the authority to halt production or even shut down polluting mills
4. **Incentives**: link environmental targets to government official assessment
5. **Information disclosure:** regularly disclose environmental condition and encourage public participation, including public interest litigation on environmental issues
6. **Closing legal loopholes** of the previous Law

Source: News information complied by Goldman Sachs Global Investment Research, www.chin5e.com.

April 2015: The Water Pollution Control Action Plan (Water Ten)

Exhibit 91: Water Pollution Control Action Plan

Overal target	By 2020, 70% of the water in China's seven major watersheds and 93% of the drinking water sources in prefecture-level cities are to meet an acceptable standard. By 2030, the Plan raises these targets to 75% and 95%, respectively. The Plan also calls for the reduction of the prevalence of "black and odorous water bodies" in prefecture-level cities to less than 10% by 2020, and the elimination of this problem by 2030.
	Key measures
1	**Pollutant Discharge Control**
	a) **Industrial Production.** The Plan anticipates the imposition of cleaner production standards for ten major industries: papermaking, nitrogen-based fertilizers, steel, nonferrous metals, textiles, agricultural products, pharmaceuticals, leather tanning, pesticides, and electroplating. The Plan also promises inspection and closure of facilities in these and other industries if they continue to use highly polluting production methods.
	b) **Wastewater Treatment.** The planned Pollutant Discharge Control program includes a nationwide infrastructural expansion of both industrial and municipal wastewater treatment facilities. The Plan states that all clusters of concentrated industrial development must have centralized wastewater treatment facilities with water quality monitoring equipment installed by the end of 2017. By 2020, all the counties and major towns should have installed sewage treatment system, and the sewage treatment rate should reach 85% and 95% for counties and cities, respectively.
	c) **Sludge treament.** The installed sludge treatment equipment should be udgraded to meet with the standard by end of 2017, and the sludge treatment rate in prefecture-level cities should be no less than 90%.
2	Economic Restructuring
	a) Utilization rate of recycled water should be more than 20% in cities with water shortage and more than 30% in Beijing-Tianjin-Hebei region.
3	Conservation And Protection Of Water Resources
4	Scientific And Technological Support
5	**Market Mechanisms**
	a) **Accelerating water tariff reform.** All cities above county level should implement progressive water tariff by 2015, and nation wide all non-residential water consumption over planned voulme should be charged with progressive water tariff by 2020.
	b) **Improve the pricing policy.** Revise the collection and management method of urban sewage treatment fee, sewage charge fee, and water resources fee. Raise the fee to a reasonable level which is not lower than treatment and disposal costs. Groundwater water fee collection standards should be higher than surface water, water resources fee in groundwater overdraft area should be higher than the non-exploitation areas.
	c) **Tax policy support.** Remove import tariff of the key components and raw materials used to manufacture large-scale environmental protection equipment; Accelerate the legislative work of environmental taxes, tax reform resource taxes. Impose consumption tax on products made with high energy consumption and high pollution.
6	Environmental Regulation And Enforcement
	a) **Ensure law enforcement**. All companies must be compliant with the sewage discharge standards. If a company is not compliant, it will receive a "yellow card" warning, and its production will be restricted or halted for remdiation; If it still can not meet the requirements of the regulation, it will receive a "red card" notice and it will be shut down. From 2016, MOEP will regularly publish the namelist of "yellow card", "red card" companies.
7	Environmental Management
8	Protection Of The Aquatic Ecological Environment
9	Differentiated Responsibilities of related parties
10	Public Participation And Social Supervision

Source: State Council, www.natlawreview.com.

Upcoming new initiatives

We expect China to continue rolling out new initiatives: 1) China's environmental improvement blueprint in the 13th Five-Year Plan; 2) discourage pollution through the introduction of Environmental Taxation and the further implementation of Carbon Trading and Pollution Rights Trading; 3) expected roll out the Soil Ten later this year; and 4) further open up the industry to the private sector through the introduction of PPP and TPT to secure more funding.

China has already announced a doubling of the pollution discharge unit free, effective January 2016. We expect China to further increase its taxation on pollution to: 1) fund pollution reduction efforts; and 2) discourage pollution.

Exhibit 92: Environmental taxation – global experiences and China's status quo

Country	Year	Taxes charged
US	1970s	CO2 tax, carbon tax, resources tax, gasoline tax and exploration tax
Sweden	1991	CO2 tax, electricity tax, nuclear energy tax, and pollution tax
Denmark	1992	CO2 tax, gasoline tax, diesel tax, coal tax, waste water tax, and solid waste tax
Japan	2007	CO2 tax, and global warming solution tax on fossil fuels
China	2003	Start the collection of pollution discharge fee
	2007	State Council states it's considering raising the resources tax rate and setting favorable tax rate for energy conservation and emission reduction projects
	2014	China announced to double the pollution discharge unit fee, effective Jan 2016

Source: Shanghai IE Expo conference materials.

Meanwhile, we expect China to further promote carbon trading in the coming 13th Five-Year Plan in order to incentivize emitters to further reduce emissions. Compared to developed countries, China has just taken a baby step in this aspect. The EU's carbon trading market grew 18 times in 2005-2011 to US$148 bn while China's total transaction value was only US$200 mn as of March 2015.

Exhibit 93: Carbon trading – global experiences and China's status quo

Global

- **Kyoto Protocol:**
  - Clean development mechanism (CDM)
  - Joint implementation
  - Int'l emission trading
- **Transaction value**
  - US$148bn in 2011 (peak)
- **Activity > 4.8%**
  - ETS (emission trading system) in EU
  - RGGI in US

China

- Launched **7 pilot cities/provinces** in 2011
  - Beijing, Shanghai, Tianjin, Chongqing, Guangdong, Hubei and Shenzhen
- Initiated **carbon trading** (2013)
- **Transaction value**: Rmb500mn till Nov 2014
- **Activity** peak 0.87% in Beijing

Source: Shanghai IE Expo conference materials.

Lessons from developed economies

Starting in the 1940s, environmental pollution in the US, the UK and Japan became increasingly acute and a number of highly influential pollution incidents occurred, including smog in Los Angeles in 1943 and London in 1952, Japan's Minamata disease outbreaks in 1953-1965, and the "itai-itai" disease related to a cadmium poisoning incident in Japan's Toyama prefecture (1955-1972). This series of incidents underlined that pollution had become an alarming social problem for developed nations by the middle of the 20th Century.

Exhibit 94: Developed countries began seeing major pollution incidents in the 1940s

Time	Event	Cause	Effect
1943	Los Angeles Photochemical Smog Event	Smog caused by vehicle emission absorbed sunlight, leading to chemical reaction and produced photochemical smog.	Smog caused eye pain, headaches, breathing difficulties, even death in severe cases. It also caused livestock illness, hindered plant growth, and building and material erosion.
1948	US Donora Smog Event	Sulfur dioxide and other harmful substances discharged by factories caused severe air pollution when abnormal weather occurred.	The incident caused 20 deaths, 6,000 people sick (c.43% of total residents in town).
1952	London Smog Event	Waste gas discharged during industrial production and residential coal-fired heating accumulated over the city and could not be dissipated.	The smog resulted in chest distress and suffocation. It led to over 5,000 deaths in 5 days and over 8,000 deaths in 2 months after the smog dispersed.
1953-1965	Japan Minamata disease event	Nitrogen producers discharged industrial wastewater with mercury, which was converted to highly toxic substance and entered into human bodies through food chain after eaten by aquatic life.	High toxic substances infringed the brain and other body parts, damaged nerve cells. The disease caused over 1,000 deaths. Number of sick people up to 10,000.
1955-1972	Japan Toyama Itai-itai disease	Wastewater discharged by zinc smelters with large amounts of cadmium caused rice and fish contamination. The substance went into human bodies through the food chain.	Cadmium causes a huge loss of calcium in the bones, leading to bone atrophy, joint pain and even minor activities can cause fractures. The disease caused more than 200 deaths.
1961	Japan Yokkaichi asthma event	Waste gas and water discharged by oil companies caused smoggy skies all year round. Aquatic products were not edible.	Many people had headaches, vomit and other symptoms. Asthma patients surged. The event caused up to 6,000 people sick and some of them died.

Source: Goldman Sachs Global Investment Research, consolidated press reports.

In the 1960s and 1970s, developed countries became more aware of the hazards of environmental pollution, and they worked to combat them when their per-capita GDP was about US$5,000-US$6,000. Developed countries began to adopt measures when the first signs of environmental pollution appeared, e.g., the UK's 1876 Rivers Pollution Prevention Act and the American Rivers and Harbors Appropriation Act of 1899 in the US, but the effects were minor. Following a series of major pollution incidents, these countries established dedicated environmental protection bodies and enacted a new series of environmental protection laws. In the 1960s and 1970s, developed countries began systematic environmental pollution mitigation by greatly increasing investment.

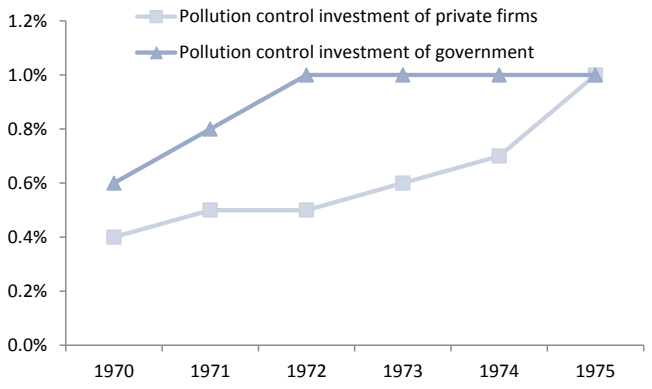
Exhibit 95: Pollution incidents have prompted countries to enact environmental protection laws

Country	Time	Law	Category
UK	1847	Town Improvement Clauses Act	Comprehensive
	1863	Alkali etc Works Regulation Act	Air Pollution
	1876	Rivers (Prevention of Pollutions) Act	Water Pollution
	1956	Clean Air Act	Air Pollution
	1960	Noise Abatement Act	Noise Pollution
	1974	Control of Pollution Act	Comprehensive
US	1948	The Federal Water Pollution Control Act	Water Pollution
	1955	Act to Provide Research and Technical Assistance Relating to Air Pollution Control	Air Pollution
	1969	Nation Environmental Policy Act	Comprehensive
	1972	Clean Water Act	Water Pollution
	1976	Solid Waste Disposal Act	Solid waste
Germany	1869	Empire Operation Law	Comprehensive
	1957	Federal Water Law	Water Pollution
	1960	Federal River Purification Law	Water Pollution
	1965	Air Purification Law	Air Pollution
	1972	Federal Waste Management Law	Solid waste
	1976	Federal Natural Conservation Law	Comprehensive
Japan	1967	Basic Environmental Law	Comprehensive
	1968	Air Pollution Control Law	Air Pollution
	1970	Water Pollution Control Law	Water Pollution
	1973	Pollution-related Health Damage Compensation Law	Comprehensive

Source: Media reports compiled by Goldman Sachs Global Investment Research.

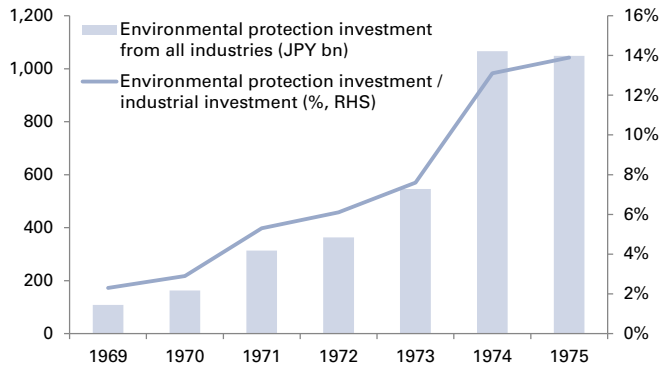
Following a number of highly influential pollution incidents, Japan embarked on large-scale investment in environmental cleanup during the 1970s. Private and public investment in pollution control in Japan grew from 1.0% of GDP in 1970 to 2.0% of GDP in 1975. Total investment in pollution prevention increased from ¥109 bn in 1969 to ¥1,049 bn (a CAGR of 46%) and 80% was aimed at the petroleum processing, chemical, steel, transportation and electrical power industries. Investment in pollution prevention went from 2.3% of total industrial investment in 1969 to 13.9% in 1975.

Exhibit 96: Japan's environmental investment as a percentage of GDP rose rapidly in the 1970s
Pollution control investment as % of GDP



Source: Development Bank of Japan.

Exhibit 97: Spending on environmental protection rose significantly for all of Japan's industries in 1969-75

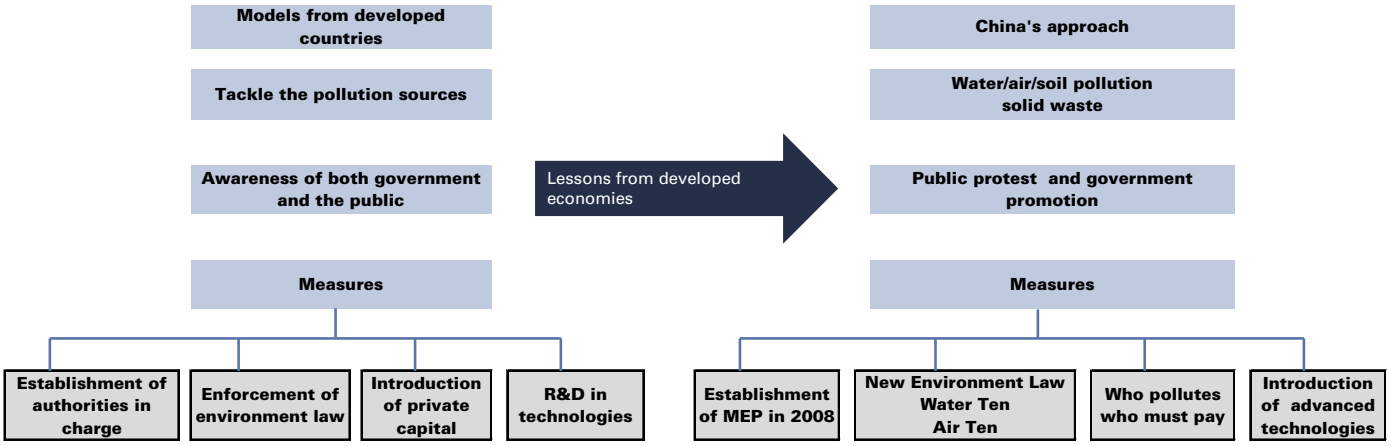


Source: Development Bank of Japan.

History shows that China's pollution is curable

The history of pollution in developed economies such as the US, Japan and the UK suggests China's pollution is severe in terms of its scale and how quickly it has developed, but this is not unexpected given China's rapid industrialization and urbanization. Moreover, the experience in developed economies also shows that severe pollution is curable.

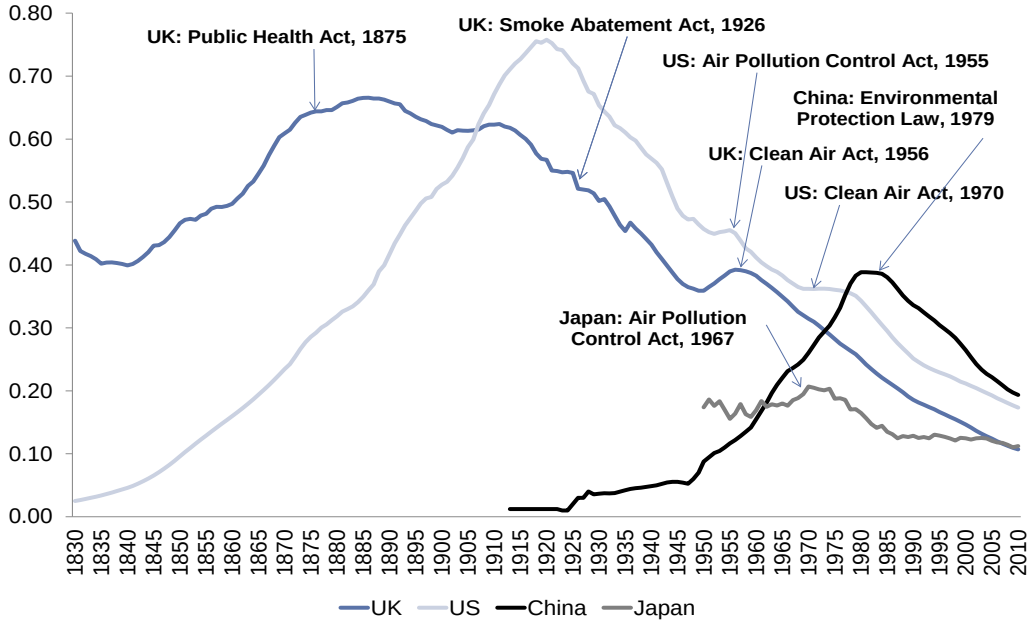
Exhibit 98: China is on track to follow approaches taken by the developed countries



Source: Media reports compiled by Goldman Sachs Global Investment Research.

Exhibit 99: Historical air pollution trend

1,000 metric tons of carbon emissions per million dollars of GDP, 10-year moving average



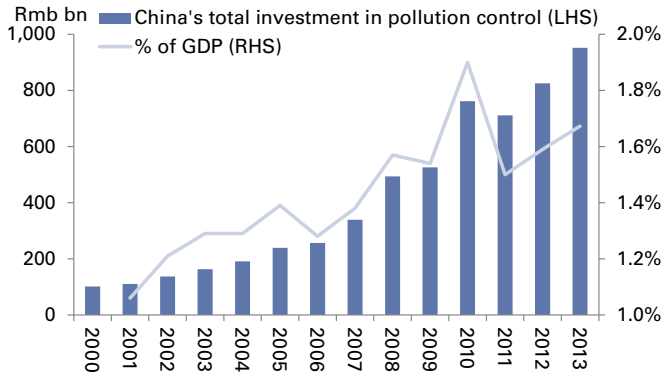
Note: GDP is PPP and commodity price adjusted, constant 1990 dollars.

Source: World Bank, CDIAC (Tom Boden, Bob Andres, Gregg Marland), Angus Maddison, Wikipedia.

China under-invested, but catching up

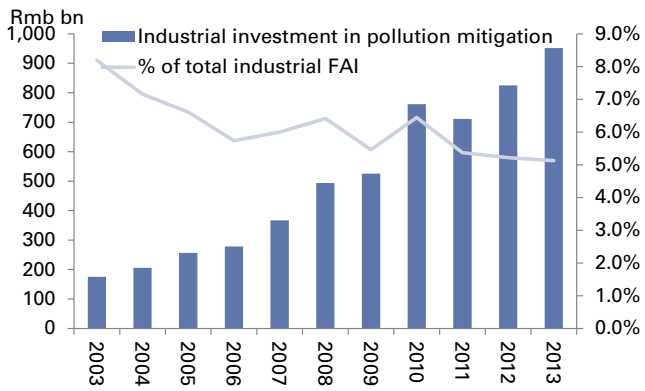
Prior to 2013, China had significantly underspent on environmental protection. In 2013, China's anti-pollution investment amounted to just 1.7% of GDP, and industrial enterprises' anti-pollution investment was only 5.1% of total FAI, even lower than the 2000 level of 6.4%. This suggests environmental protection has been a very low priority for both the government and industrial corporates.

Exhibit 100: China's anti-pollution investment remains low as a percentage of GDP
2000-2013



Source: China Statistical Yearbook on the Environment, Wind.

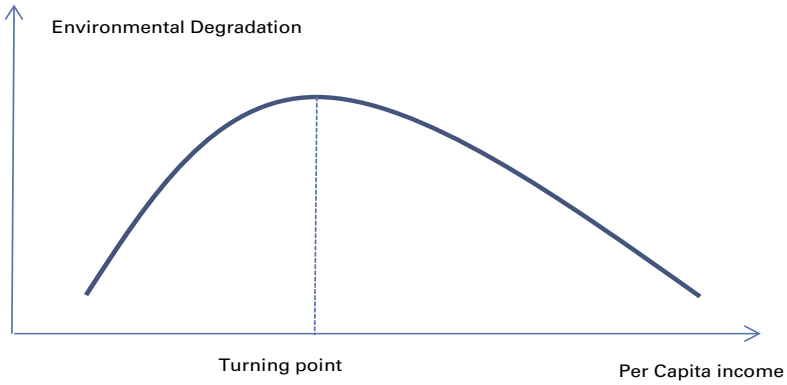
Exhibit 101: Industrial investment in pollution mitigation is declining as a percentage of total investment
2003-2013



Source: Wind.

Based on the EKC (Environmental Kuznets Curve by economist Simon Kuznets), in the early stages of economic development, environment quality worsens as per-capita income increases; however, when per-capita income passes a certain level, environment quality begins to improve in line with income. Such environment improvement is not a natural result of higher income; instead, it requires effort on every front.

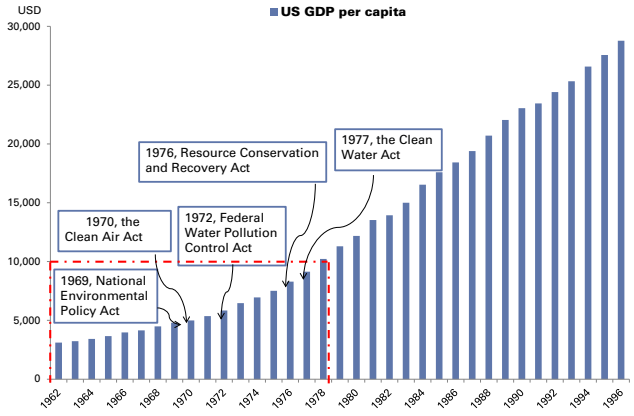
Exhibit 102: The Environmental Kuznets Curve



Source: The Environmental Kuznets Curve: a Survey of the Literature by Simone Borghesi.

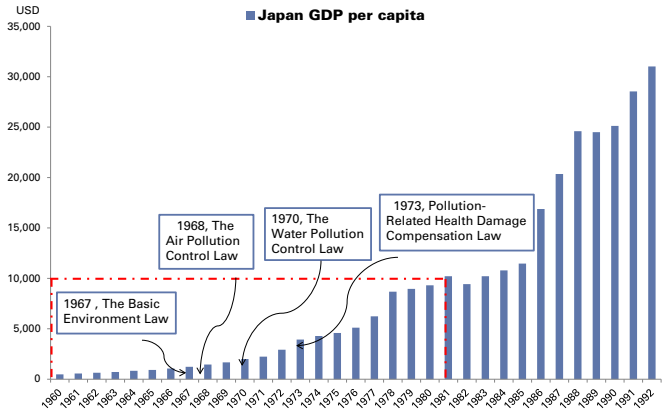
Major developed countries enacted a series of environmental laws and regulations when their per-capita GDP reached US$5,000-10,000. Per-capita GDP in the US was US$10,225 in 1978 when the Clean Air Act, Resource Conservation and Recovery Act and the Clean Water Act were passed or significantly amended in 1970, 1976 and 1977, respectively. When Japan's per-capita GDP reached US$10,212 in 1981 and Germany's reached US$10,916 in 1979, both countries also passed a series of key environmental laws and regulations.

Exhibit 103: The US passed a number of key environmental laws and regulations in 1969-1977



Source: Wind.

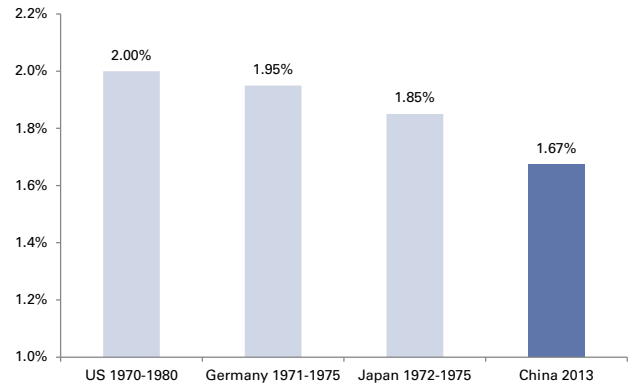
Exhibit 104: Japan passed a number of key environmental laws and regulations in 1967-1973



Source: Wind.

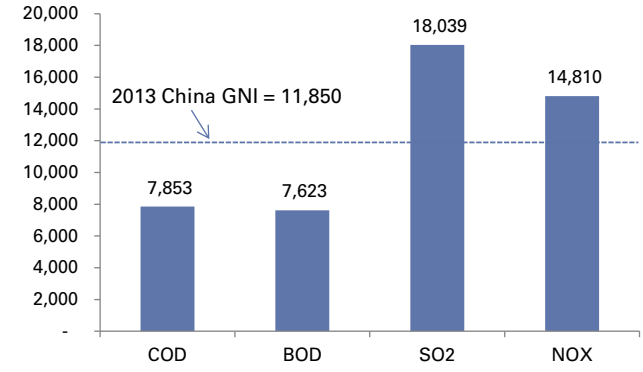
Compared to the major developed countries, China's current environmental investment – a GDP ratio of 1.5% – is even lower than for those countries during their respective pollution clean-up phases around 40 years ago. Considering the magnitude of Chinese pollution is far more acute than in those countries, we believe China would have to invest significantly more in environmental protection over the next 5-10 years.

Exhibit 105: China has underinvested in environmental protection
Investment/GDP ratio during pollution control period



Source: www.chanyezixun.com, Wind.

Exhibit 106: China's gross net income is approaching the turning point for some pollutants
Turning point for various pollutants (GNI per capita, US$)

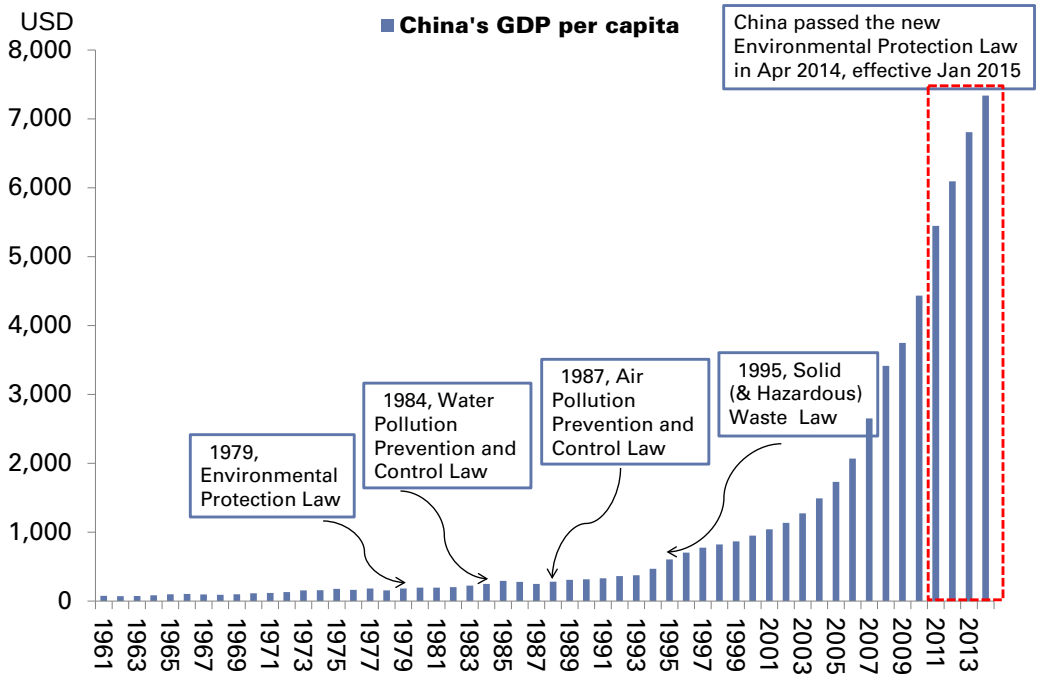


Note: COD is Chemical oxygen demand; BOD is Biological oxygen demand.

Source: The environmental curve by James Van Alstine and Eric Neumayer, Cole and Neumayer (2005: 310), Grossman and Krueger (1995), Cole (2003), Stern and Common (2001), Goldman Sachs Global Investment Research.

In 2013, China's per-capita income was Rmb41,805, or approximately US$6,798, according to the National Bureau of Statistics (NBS). Based on the experiences of the major developed countries including the US, Japan, the UK and Germany, we believe China has already entered a phase where it can and must increase its investment in environmental protection.

Exhibit 107: China's per-capita GDP is high enough to take the country into a new era of environmental protection

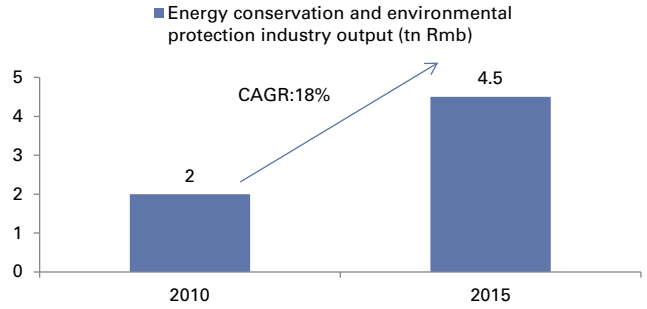


Source: Wind, World Bank.

The encouraging development is that, following a number of significant pollution incidents, such as prolonged smog in North China and severe water pollution incidents in several regions, China has stepped up efforts to enact new environmental law (effective January 1, 2015) and committed a large amount of capital on environmental protection. In 2008, China established the MEP and in 2012, at the 18th Communist Party conference, China added environmental protection to the four "platforms".

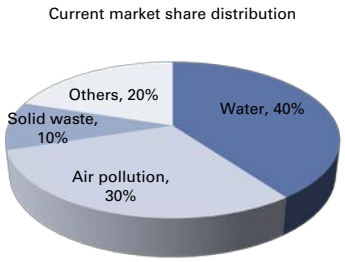
According to the MEP, the total industry output of environmental protection is estimated to reach Rmb4.5 trn in 2015, more than double from Rmb2 trn in 2010, representing an 18% CAGR in 2010-2015. Water cleaning and treatment remains the largest sub-sector, accounting for around 40% of total industrial output.

Exhibit 108: China environmental industry's output growth in 12th Five-Year Plan period



Source: 12th Five-year plan for the Energy Saving and Environmental Protection Industry.

Exhibit 109: Water and treatment remains the largest sub-sector



Source: China Association of Environmental Protection Industry, Goldman Sachs Global Investment Research.

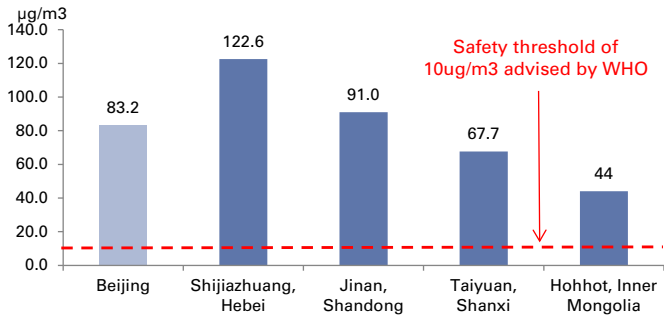
Now that environmental issues are a high priority for both the central and local governments, we expect China to significantly increase its investment in environmental improvement and protection in the coming 13th Five-Year Plan period (2016-20), making up for its chronic underinvestment in the past.

Pollution cleanup: Beijing case study

2013 had the most smog days in China since 1961, and Beijing was the most polluting city among the four municipal cities. After China declared "war on pollution" in September 2013, as the capital of the country, Beijing has made tremendous efforts to reduce emissions. The city even set an emission standard for its cement plants and coal-fired power plants higher than the EU standard. However, even with that, Beijing still failed to achieve its annual PM2.5 reduction target in 2014. Beijing targets to lower its PM2.5 level to 60mg/cm in 2017, which means the city needs reduce 25.9mg/cm in 2015-17, compared to the 85.9mg/cm as of end-2014. Considering Beijing only reduced its PM2.5 by 4% in 2014, vs. its target of a 5% reduction, it would be a big challenge for Beijing to achieve its PM2.5 reduction target by 2017 assuming its annual reduction remains at the same level as 2014 in the next three years.

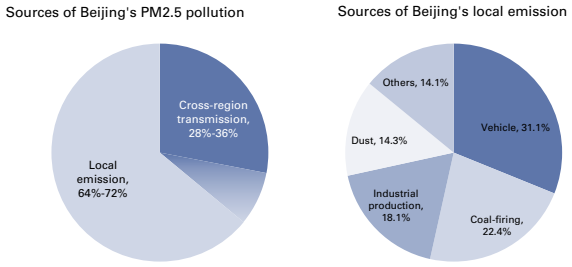
The challenging outlook for Beijing to reduce pollution demonstrates how difficult it would be for China to contain pollution over the next few years. As the nation's capital city, Beijing should have the best resources to leverage to tackle its pollution issue. However, the complexity of pollution in Beijing suggests that polluting control requires a national campaign and inter-region cooperation and coordination. Taking the source of Beijing pollution for instance, around one-third of the pollution in Beijing is actually from neighboring regions including Shanxi, Hebei, Shandong and Inner Mongolia. Such imported pollution requires "across-region" cooperation, which has been constrained by the uneven economic development and lack of coordination among these regions, making unified pollution control efforts hard to implement.

Exhibit 110: Beijing and its polluting neighbors
2014 average PM2.5 concentration



Source: Greenpeace, Ministry of Environment Protection.

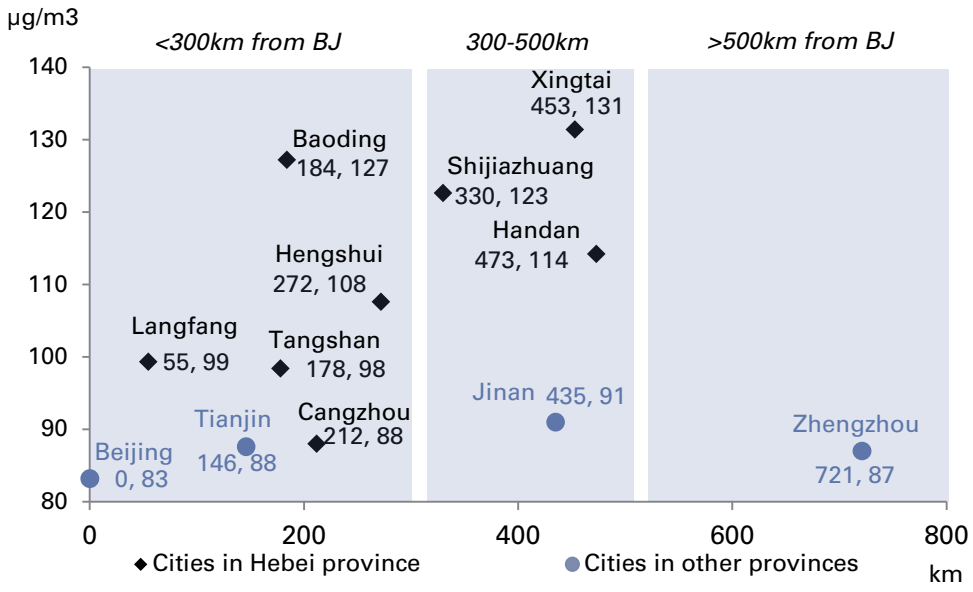
Exhibit 111: Vehicles are the largest source of local pollution
Sources of Beijing's PM2.5 pollution (result released in 2014)



Source: Beijing Environment Protection Bureau, Sanlian Life Weekly.

Furthermore, aside from eliminating the polluting industries in the city, Beijing has been relocating many heavy industries such as steel and power generation to its neighboring regions. For example, in order to improve air quality before the 2008 Beijing Olympics, Beijing moved Beijing Shougang Steel to Caofeidian, Hebei province. Though temporarily helpful for Beijing's pollution reduction efforts, relocating pollution does not eliminate the problem, and with rising awareness of the importance of environmental sustainability across the country, such an approach will become more and more difficult to implement.

Exhibit 112: Beijing's pollution control efforts require the cooperation of its neighbors
China's top 10 cities by 2014 average PM2.5 concentration vs. distance from Beijing



Source: Greenpeace, Ministry of Environment Protection.

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