Equity Strategy

Investment Strategy | China | Multiple
17 January 2011

A primer on China's seven strategic industries

Bank of America Merrill Lynch

David Cui >> +852 2536 6477
Strategist
Merrill Lynch (Hong Kong)
david.cui@baml.com

Andy Zhao >> +852 2161 7907
Strategist
Merrill Lynch (Hong Kong)
andy.zhao@baml.com

Tracy Tian, CFA >> +852 2161 7632
Strategist
Merrill Lynch (Hong Kong)
tracy.tian@baml.com

Angello Chan >> +852 2161 7187
Research Analyst
Merrill Lynch (Hong Kong)
angello.chan@baml.com

Edmond Huang, CFA >> +852 2161 7807
Research Analyst
Merrill Lynch (Hong Kong)
edmond.huang@baml.com

Shaojing Tong >> +852 2536 3974
Research Analyst
Merrill Lynch (Hong Kong)
shaojing.tong@baml.com

Thomas Wong >> +852 2161 7753
Research Analyst
Merrill Lynch (Hong Kong)
thomas.m.wong@baml.com

China's moon shot

China is in danger of slipping into overly relying on government spending and property speculation to deliver growth, in our view. With the demographic dividend ending as well, the government has been trying to jump start private investment in more productive areas to bring back economic vitality. One key initiative is the seven strategic industries announced by the State Council in Oct 2010: 1) energy saving & environmental protection; 2) new generation IT; 3) bio-tech; 4) high-end equipment; 5) new energy; 6) new materials; and 7) new energy car. In our year-ahead report, we have identified this as a major theme for the market this year ("Seven market driven themes in 2011", Jan 3). We hope our primer, including a sector-by-sector value chain analysis and names of companies in each major sub-sector, can serve as a roadmap for investors to navigate the daunting landscape.

What to expect & when

The government plans to roll out detailed policies post the 2011 National People's Congress (starting on Mar 5). We expect a mix of measures including tax relieves, subsidies, priority access to financing, IP protection, infrastructure build-out and unification of industry standards. Many of them will favor the corporate sector, whose support is critical to the success of the government's program.

Market and sector implications

1) We have identified 28 sub-sectors as fertile ground to find potential winners after considering issues such as addressable market, entry barrier, bottleneck and competition (a full list in Table 1). Some of them are well known, e.g. equipment suppliers to the high speed railway network & the grid, rare earth; others are in areas less obvious, e.g. recycling and forging. 2) Most of the potential beneficiaries are small to mid cap names rather than big cap stocks currently dominating various indices. This has reinforced our opinion that, to beat the market in the medium to long term, we should consistently underweight big caps ("The new untouchables", 13 Aug 2010) and search elsewhere for winners that better reflect where the economy is heading; 3) There is much more exposure to the new economy sectors in the A share market, so in the long term, SHCOMP will likely outperform HSCEI.

Risks and qualifications

Whether the government, having earned its stripes by tightly managing the economy, can succeed in fostering innovation remains to be seen. There are two significant hurdles in our opinion: 1) resistance from interest groups; and 2) a lack of institutional framework, e.g. IP rights. By the way, we have listed hundreds of stock names in the report but the listing itself does not mean that we endorse their investment cases.

Contents

Executive summary
China's moon shot

At the height of the Cold War and faced with a seemingly insurmountable lead in space technology by the Soviet Union, President Kennedy captured the nation's imagination by declaring that the US would land a man on the moon and return him safely to the earth within a decade. Being inspirational, Kennedy famously proclaimed, "But why, some say, the moon? … And they may well ask why climb the highest mountain? … We choose to go to the moon … not because they are easy, but because they are hard". In reality, the space project was a great way to mobilized people's energy and promote innovations which ultimately helped to defeat the economic and political system of the Soviet Union. Many of the technologies advanced by the Apollo program are still enriching our lives today, e.g. satellite communications and dried fruits!

Today, China is doing its equivalent of the "moon shot", namely, the **SEVEN STRATEGIC INDUSTRIES**.

China is at a critical juncture: three decades of supercharged growth has caused the country many serious problems including labor shortage, stretched global resources supply, unequal distribution of income, social tension and pollution on a scale unprecedented in human history. Many of these ills were brought about, directly or indirectly, by China's past reliance on investment to deliver growth.

The Chinese government has made up its mind to reposition the country's economy on the path of more sustainable growth, driven by innovation, efficiency and productivity gains rather than low level investment ("The visible hand – A reform roadmap & what it means", 23 July 2010). This is where the seven strategic industries come into the picture.

The stake for China is high ideologically as well. Socialism with Chinese characters has worked well for China so far. But the road ahead is tougher. In a way, an economy that's heavily managed by the state has it advantages at the early stage of industrialization. This is because the government can effectively suppress consumption, mobilize savings and build critical projects. For proof of this, we need to look no further than the Soviet Union and Japan in the 1950-60s and China over the past 30 years. But ultimately, an economy needs innovation and productivity gains to deliver long term sustainable growth after resources, including labor, become more scarce. The question facing China now is whether the government, having earned its stripes by tightly managing the economy, can foster innovation as well.

The seven strategic industries

In Oct 2010, the State Council formerly announced its decision to target seven industries for focused development and they are 1) energy saving & environmental protection; 2) new generation IT; 3) bio-technology; 4) high-end equipment; 5) new energy; 6) new materials; and 7) new energy car.

Table 1 gives out more details on the key areas targeted by the government in each industry and our assessment on which sub-sectors are most attractive for investors from a top down perspective.

Table 1: The seven strategic industries

Industry	Key focuses	Sectors with attractive investment characters
Energy saving & environmental protection	Highly efficient energy saving equipments & products; Key technologies in resource recycling; Services of energy saving & environmental protection; Pollution control; Clean coal; Recycling of waste/used goods; Advanced environmental protection equipment & products; Sea water usage.	Substrate; Battery cycling; High-voltage inverter/Energy Management Contract (EMC); Coal bed methane (CBM).
New generation IT	Three network integration; The Internet of things; Cloud computing; High-end software; High-end server; Virtual digital technology; New display technology; IPV4 core equipment.	Cable operators; software.
Bio-technology	Bio-medicines, chemical medicines, TCM, diagnostic reagents and new vaccines for major disease prevention & control; Advanced medical equipment & materials; Bio-breeding, green agriculture; Bio-production; Marine biology.	Cancer drug makers; Traditional Chinese medicine (TCM); Diagnosis, monitoring and treatment (DMT); bio-breeding.
Hi-end equipment	Regional aircraft, large aircraft and general-purpose aircraft; Aerospace, satellite and their applications; Track-based transportation equipment, including those for passenger train and metros; Offshore equipment; Digital, flexible, integrated intelligent equipment.	Aircraft manufacturing; Satellite navigation; Equipment and parts for high-speed trains; Offshore engineering; Intelligent Manufacturing Equipment.
New energy	Next-generation nuclear power technology, nuclear power plants with advanced technology; Solar; Wind power equipment, wind power plants, smart grid and related systems that can accommodate new energy sources; Bio energy; Smart grid.	Nuclear; Forging; Wind; Smart Grid
New materials	Rare earth, high performance membrane, special-usage glass, functional porcelain, LED; High performance special steel, new alloy, and engineering plastics; High-performance fibers and composites; Nano, superconducting, intelligent materials.	Rare earth; Magnetic materials; Membrane bioreactor; High temperature filter; Carbon fiber composite; Aramid fiber composite; Superconducting materials.
New energy cars	Core technologies including those in battery, electric motor and electric control system; Plug-in hybrid car, electric car; Fuel cell.	Charging station; Lithium battery.

Source: BofA Merrill Lynch Global Research

We believe the following sub-sectors are fertile ground for us to identify potential beneficiaries from the government's strategic industry initiatives: substrate; battery cycling; high-voltage inverter/Energy Management Contract (EMC); coal bed methane (CBM); cable operators; software; cancer drug makers; Traditional Chinese medicine (TCM); diagnosis, monitoring and treatment equipment (DMT); bio-breeding; aviation; satellite navigation; equipment and parts for high-speed trains; offshore engineering; intelligent manufacturing equipment; nuclear; forging; wind; smart grid; rare earth; magnetic materials; membrane bioreactor (MBR); high temperature filter; carbon fiber composite; Aramid fiber composite; superconducting materials; charging stations for electric car; lithium battery.

Throughout our report, we have listed hundreds of listed companies that have exposure to these sectors. We'd like to stress that this doesn't mean we endorse their investment case. Most of these companies we have never met so can not vouch for management. In addition, we take no consideration of many other investment considerations including valuation.

Most of these companies are small to mid cap names, and unfortunately for overseas investors, they are more often than not listed on the domestic A share market. Another point we'd like to mention is that there are clear sufferers from the government's program, for example, those with operations that are energy and pollution intensive so they may be forced to fund many of these government initiatives. But they are not the focus of this report.

Why are these seven chosen?

We believe that they are selected for a number of reasons.

- **They are important technologies experiencing major breakthroughs**: they have broad applications and are at the forefront of the new round of industrial revolution, e.g. new generation IT and new materials. So in a way China can not afford to lag much behind. When choosing the list, China has also taken into account whether it has a realistic chance of competing with the best in the world, e.g. new energy car.

- **They address issues that are limiting China's growth potential**, e.g. pollution, unaffordable healthcare, access to energy, and transportation bottleneck.
- **They bring new and significant growth opportunities for the economy**, e.g. aviation, new energy cars.
- **They improve national security**, e.g. alternative energy sources to reduce China's reliance on imports, home-grown satellite navigation system and software suppliers.
- **They belong to areas that China has competitive advantages**, e.g. rare earth resources, those with a big local market so China can exchange market for technology (nuclear, aviation, high-speed train etc.), low cost engineering (off-shore etc.) and those that can benefit significantly from government sponsorship (smart grid, charge stations for electric cars, etc.)
- **They reduce imports (thus cutting costs) and potentially can be exported**, e.g. intelligent machinery.

Many of the chosen fields can fulfill multiple purposes, e.g. electric cars on employment, environmental issues and export potential. The more the merrier.

Overall, we suspect the list is not set in stone and will evolve over time. Similar to the Rmb4tr stimulus package, it is more a show of the government's determination to promote innovation in our opinion. It's the first time that the government has named certain industries strategic although there was never a shortage of areas that the government wanted to support in the past.

The concept of strategic industry is different from that of the pillar industries. The traditional pillar industries that the government has been targeting include real estate, automobile, non-ferrous metals, steel, equipment manufacturing, IT, textiles, shipbuilding, petrochemical, and light manufacturing industry, and they are chosen largely because of their size and long value chain, so meaningful impact on the economy. As stated earlier, the reasons behind the strategic industries are more complicated.

Government goals and policies

The government's goals for these seven industries are: by 2015, they can contribute significantly to China's drive to upgrade its industries and make up approximately 8% of China's GDP; by 2020, they can become world leading in selected areas and account for approximately 15% of GDP with energy saving and environmental protection, new generation IT, bio-technology, and high-end equipment developing into new pillar industries; by 2030, all of them achieve world class status and provide strong support to China's sustainable growth.

The government may continue some and roll out more measures to achieve these goals and these measures may include:

- **Tax concessions**, e.g. exemption and cut to corporate income tax (normally two years of exemption and three years at half of the standard rate) and to business tax; VAT rebates on high-tech equipment purchases and high-tech product exports; tax rebate for activities such as R&D; generous tax deduction allowance for R&D spending.

- **Subsidies**, e.g. research grants, direct subsidies to LED and electric car manufacturers or buyers, subsidies to recyclers.
- **More fiscal spending** on education, fundamental research and demonstration projects; encouraging researchers in universities and other institutions to commercialize their research, including working for corporate; getting universities to broaden their disciplines to support the strategic industries.
- **Better access to financing**, e.g. priority access to bank, stock and bond markets; a more developed GEM market and a potential setup of an OTC market; dedicated industry specific funds set up by the government; a more vibrant VC and PE market; encouraging insurance companies, pension funds and other financial institutions to participate in the VC and PE market.
- Legal system and other measures to ensure **fair sharing of the benefits of innovations**, including **IP protection**, e.g. better enforcement of IP laws, systems to reward innovations via equity ownership, stock options, dividend, and the setup of an exchange for IP rights.
- **International co-operation** in R&D, technology imports and digestion, e.g. overseas acquisition (e.g. Geely/Volvo), market for technology (.g. high-speed railway), local content requirement for government projects (e.g. nuclear power), incentives for multi-nationals to set up R&D centers and to invest in the strategic industries in China, incentives to attract overseas talents to come and work in China, and measures to encourage domestic firms to develop outsourcing business and set up overseas research centers.
- **Administrative orders**, e.g. new energy as a percentage of total output at IPPs and compulsory energy savings target on local officials.
- **Preferential pricing and other treatments**, e.g. favorable pricing mechanism for new drugs and new energies; guaranteed connectivity for new energy generation.
- **Forcing upgrades**, e.g. resources tax, carbon tax and environmental tax on high energy consuming and highly polluting industries, higher prices on some traditional energy sources such as oil, tightened discharge and other pollution standards, carbon trading scheme.
- **Infrastructure build-out**, e.g. accelerator, super speed computer, smart grid and charging station network for electric cars, **fostering co-operation**, e.g. between the corporate sector and research institutions including universities, **unifying industry standards**, e.g. electric cars, 4G mobile technology.

Overall, the government recognizes that the participation by the corporate sector, driven by market forces, is critical to the success of its initiatives for China to improve productivity and move up the value chain. As a result, many of the above mentioned measures revolve around providing incentives to corporate, a major positive to companies in the right areas in our opinion.

Acronym

AGVS	Automated Guided Vehicle Systems
CAAC	Civil Aviation Administration of China
CATV	Community Antenna Television
CBM	Coal Bed Methane
CBRC	China Banking Regulatory Commission
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CFB	Circulating Fluidized Bed
CFL	Compact Fluorescent Lamp
CMC	Central Military Commission
CNC	Computerized Numerical Control
COMAC	Commercial Aircraft Corporation of China, Ltd
CPC	Communist Party of China
DMT	Diagnosis, Monitoring and Treatment
DP	Drilling Platform
DTV	DIRECTV
EMC	Energy Management Contract
EV	Pure Electric Cars
FACTS	Flexible AC Transmission System
FPSO	Floating Production, Storage and Offloading
GIS	Geographic Information System
GNSS	Global Navigation Satellite Systems
HEV	Hybrid Cars
HSR	High-speed Railway
HVDC	High-voltage Direct Current
IEA	International Energy Agency
IGBT	Insulated Gate Bipolar Transistor
IGCC	Integrated Gasification Combined Cycle
IPP	Independent Power Producer
IPTV	Internet Protocol Television
IT	Information Technology
LBS	Location-based Service
LCO	Lithium Cobalt Oxide
LCR	Local Content Ratio
LED	Light Emitting Diode
LFP	Lithium Iron Phosphate
LMO	Lithium Manganese Oxide
LNG	Liquefied Natural Gas
LPG	Liquid Petroleum Gas
LTO	Lithium Titanium Oxide
MIIT	Ministry of Industry and Information Technology
MOA	Ministry of Agriculture
MOC	Ministry of Commerce
MOEP	Ministry of Environmental Protection
MOF	Ministry of Finance
MOH	Ministry of Health
MOHURD	Ministry of Housing and Urban/Rural Development
MOLR	Ministry of Land and Resources
MOR	Ministry of Railway
MOST	Ministry of Science and Technology of the People's Republic of China
MRO	Maintenance, Repair and Overhaul
MSW	Municipal Solid Waste
NBE	National Bureau of Energy
NDRC	National Development and Reform Commission
PBOC	People's Bank of China
PHEV	Hybrid cars that have an electric plug
PMSM	Permanent Magnet Synchronous Motor
PND	Portable Navigation Device
RFID	Radio Frequency Identification Device
RGVS	Railroad Guided Vehicle System
SAE	State Administration of Energy
SARFT	State Administration of Radio, Film and Television

AGVS	Automated Guided Vehicle Systems
SASAC	State-owned Assets Supervision and Administration Commission
SAT	State Administration of Taxation
SEC	State Energy Committee
SEPA	State Environmental Protection Administration
SFDA	State Food and Drug Administration
SIC	State Information Center
SOE	State-owned Enterprise
Solar PV	Photovoltaic Solar
SRM	Switched Reluctance Motor
STB	Set Top Box
TCM	Traditional Chinese medicine
UHV AC	Ultra High Voltage Alternating Current
UHV	Ultra-high voltage
UN	United Nation
VAS	Value Added Service
VAT	Value Added Tax
VOD	Video-on-demand
WHO	World Health Organization
WTG	Wind Turbine Generator

Source: BofA Merrill Lynch Global Research

Energy Saving & Environmental Protection

No. 1 on the government's strategic industry list.

In the State Council's announcement about the seven strategic industries, Energy Savings & Environmental Protection ranks the first, demonstrating its importance in the government's mind. The document specifically mentions the following areas as key focuses: high efficiency energy saving and environmental protection equipments & products, key technologies in resources recycling, market driven energy saving & environmental protection service sector, used goods recycling system supported by advanced technologies, clean coal and ocean resources (Table 1.1).

Table 1.1: Energy saving & environmental protection sector overview

Targeted areas	Policies	Relevant stocks
Highly efficient energy saving equipments & products (高效节能技术装备及产品)	In addition to the usual tax and other benefits afforded to high-tech industries: China has banned sales of low efficiency motors, and is subsidizing the purchase of high efficiency motors and high efficiency air conditioners (which use high efficiency motors); NDRC has launched the Green Light Project to promote energy-saving lighting since 1996, and subsidized the purchase of 312mn CFLs; China has subsidized energy management contract (EMC) service providers for energy saved and mandated the use of better heat-proofing materials to cut buildings' energy consumption; China has encouraged the extraction of metals from recycled batteries; China may launch environmental tax and carbon tax in 2011 at the earliest.	High efficiency motors: Broad Ocean Motor (002249 CH), Haier (1169 HK), Wolong Electric Group (600580 CH) Low emissivity glass: CSG (000012 CH), Anyuan Industrial (600397 CH), Xinyi Glass (868 HK), Avic Sanxin (002163 CH) CFP bulb makers: Beijing New Building Materials (000786 CH) Gypsum board: Zhejiang Yankon (600261 CH), CNlight (002076 CH) Cobalt and nickel recycling: Shenzhen Green Eco-Manufacture (002340 CH) EMC: Tsinghua Tongfang (300070 CH), Tellhow Sci-Tech (600590 CH) High voltage inverter: Hiconics Drive Technology (300048 CH), Harbin Jiuzhou Electric (300040 CH), Guangzhou Zhiguang Electric (002169 CH), Hubei Tri-Ring (000883 CH), Rongxin Power (002123 CH)
Key technologies in resource recycling (资源循环利用关键共性技术)		
Services of energy saving & environmental protection (市场化节能环保服务体系)		
Pollution control (污染防治)		
Clean coal (煤炭清洁利用)		
Recycling of waste/used goods (废旧商品回收利用体系)		
Advanced environmental protection equipment & products (先进环保技术装备及产品)		Denitrification: Jiulong Electric Power (600292 CH), Pan Asia Env (556 HK) Desulfurization: Beijing SJ Env Protection (300072 CH), Shanda Wit Sc& Tech (000915 CH), Western Metal Materials (002149 CH), Jiulong Electric Power (600292 CH), East Lake High Tech (600133 CH) Dust removal: Xiamen Savings Env (300056 CH), Fujian Longking (600388 CH), Zhejiang Feida Env (600526 CH) Carbon capture: Tianyi Science &Tech (600378 CH)
Sea water usage (海水综合利用)		

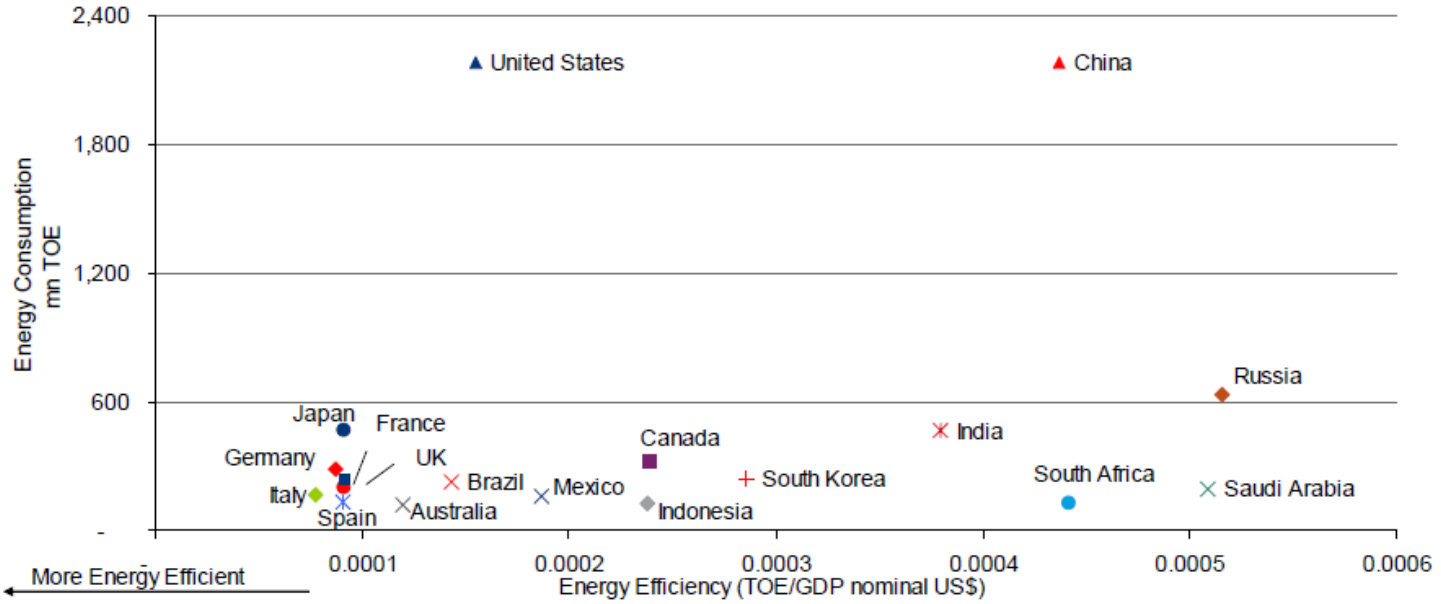
Source: BofA Merrill Lynch Global Research

Environmental issues in China are dire

China has paid a heavy toll for its rapid economic growth over the past thirty years.

China has paid a heavy toll for its rapid economic growth over the past thirty years. By 2009, it ranked as the second largest energy user although the size of its economy was far small. As a result, China consumed 7x as much energy as Japan, 6x as much as the US, and 2x as much as India, per unit of GDP output (US$ equivalent) in 2009 based on data provided by BP (Chart 1.1).

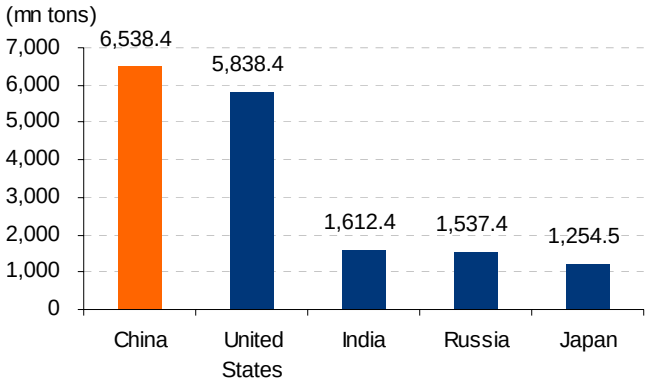
Chart 1.1: Energy consumption efficiency – 2009



Source: BP Statistic Review 2010, IMF, BofA Merrill Lynch Global Research

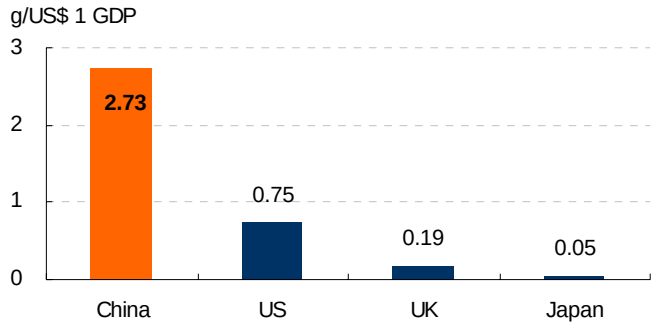
China's pollution discharge is also staggering. It's the largest CO2 emitter globally and its SO2 emission per US$ output is some 3.7x that of the US and 58.1x that of Japan's (Chart 1.2 and 1.3).

Chart 1.2: CO2 emission world rankings



Source: United Nations Millennium Development Goals Indicators

Chart 1.3: SO2 emission world rankings



Source: China Geology & Resources Research Institute, NPC, BofA Merrill Lynch Global Research

Table 1.2: Economic cost of water pollution & depletion

	RMB bn
Cost of polluted water held back from supply	85,429
Cost of polluted water in supply	61,258
Cost of ground water depletion	92,356
Total	239,043

Source: World Bank 2005

The economic and social costs of pollution are high. Water pollution & depletion alone cost China a stunning Rmb239bn in 2006, or 1% of its GDP (Table 1.2). A recent survey conducted by Sohu.com showed that 60% of participants rated "deteriorating environment" as their No. 1 reason to potentially emigrate. Based on various sources:

- 20 of the 30 most polluted cities in the world are in China;
- 400,000 Chinese citizens die of air pollution-related causes each year;
- One-third of China suffers from acid rain;

- Only 1% of China's urban population breaths uncontaminated air;
- Beijing's air quality failed to meet WHO standards over 80% of the time in 2008;
- Over 25% of China's rivers, lakes, and streams were too contaminated to be used for drinking water;
- 500 million people do not have access to clean drinking water;
- All seven of China's major rivers are polluted.

Government policy responses

The Chinese government has set ambitious targets to improve energy efficiency and reduce pollution.

The Chinese government has set ambitious targets to improve energy efficiency and reduce pollution. It aims to:

- reduce per GDP unit energy consumption by 17.3% during the 12th Five-Year Plan period (2011-2015) and another 16.6% during the 13th Five-Year Plan period (2016-2020). These will be in addition to the 20% reduction targeted during the 11th Five-Year Plan period (2006-2010);
- cut oil consumption per GDP by 10% by 2015;
- cut water consumption per GDP by 50% by 2020, and another 40% by 2030;
- reduce China's per GDP unit CO2 emission by 40-45% (compared to 2005) by 2020 (Premier Wen, the Copenhagen Climate Conference, Dec 2009).

They government may employ a broad range of tools to achieve its targets, including …

They government may employ a broad range of tools to achieve its targets, including tightening environmental standards, raising energy and polluting costs, providing subsidies to better products and technologies, promoting renewables and administrative measures.

Regulators – no longer a toothless tiger

… more stringent supervision …

One of the key initiatives under the mega ministry reform implemented in 2008 was to elevate the State Environmental Protection Administration (SEPSA), to become the new Ministry of Environmental Protection (MOEP) with its own independent source of funding (previously largely funded by local governments).

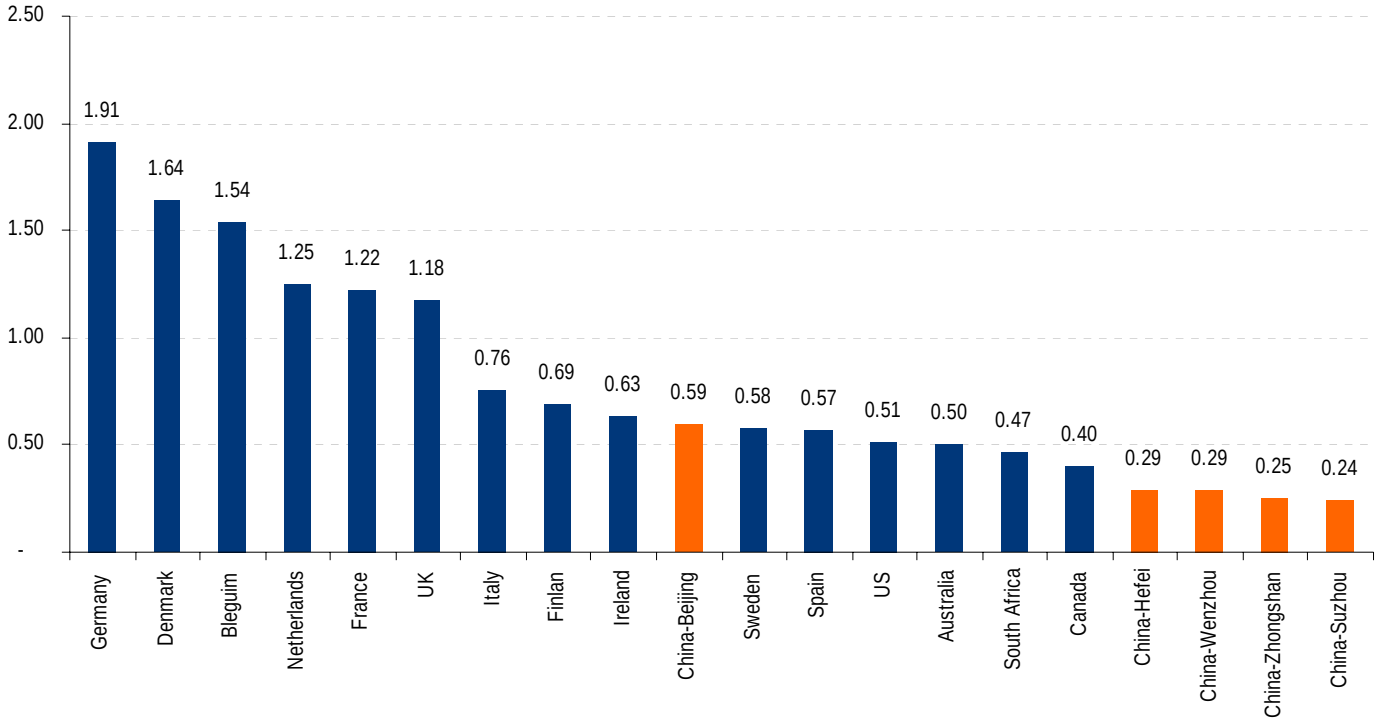
Another important development during the mega ministry reform is the set-up of the National Bureau of Energy (NBE) under the NDRC, China's central planner. In addition, the State Council announced in Jan 2010 the setup of the State Energy Committee (SEC), comprising the Premier, a vice Premier and many important ministers. The setup of such a high-powered body shows the government's determination to get its energy policy right ("State Energy Committee", 28 Jan 2010).

Raising the prices of energy and other resources

… raising the prices of energy and other resources …

China has under priced many resources in the past, including energy and water. This had discouraged conservation, distorted capital/labor returns and China's true competitiveness in the global market ("Prices reform in China", 19 May 2009). For example, despite being water-poor, water is priced very cheaply in China vs. other countries (Chart 1.4) while many consumer goods and services are priced very expensively ("The poor poor Chinese consumers", 16 Nov 2010).

Chart 1.4: Tap water prices, global vs. China



Source: UN, various news flows, BofA Merrill Lynch Global Research

Price adjustment plans for public utilities have to go through public hearing to take public opinions and affordability of the poor into account. Despite the constraint, there are many signs recently that the government is determined to raise energy and other resources prices directly or indirectly, albeit gradually in many cases, e.g. the introduction of a value-based resources tax ("Resources tax to all western regions", 06 Jul 2010), the new oil price mechanism (Thomas Wong/Vitus Leung, "Inflationary pressure not likely to hold further price hikes", 21 Dec 2010), progressive electricity charges ("Power charge reform", 11 Oct 2010) and water tariff reforms (Table 1.3). To make it easier to absorb, price increase is often phased in over a few years. For example, Beijing city decided to raise water charge by about 27% in Dec 2009 but spread the increase over three years.

Table 1.3: Water tariff hikes in China in recent months

Process	City	Effective date	After (RMB/ton)	Before (RMB/ton)	Change (%)	Note
Effective	Maanshan, Anhui	01/09/2010	1.90	1.60	*18.8*	*Residential end user price*
			2.40	2.10	*14.3*	*Residential end user (<17m³)*
			3.35	2.10	*59.5*	*Residential end user (18m³-30m³)*
			4.30	2.10	*104.8*	*Residential end user (>31m³)*
Effective	Wenzhou, Zhejiang	01/09/2010	4.10	3.55	*15.5*	*Non operating business*
			4.20	3.70	*13.5*	*Operating business (industrial & commercial)*
			7.10	6.10	*16.4*	*Special business*
			2.31	2.15	*7.4*	*Residential end user (<12m³)*
			2.77	2.15	*28.8*	*Residential end user (12m³-20m³)*
			3.79	2.15	*76.3*	*Residential end user (>20m³)*
Effective	Hefei, Anhui	01/10/2010	2.60	2.40	*8.3*	*Non operating business*
			2.65	2.35	*12.8*	*Industrial user*
			3.03	3.25	*(6.8)*	*Commercial user*
			9.00	7.00	*28.6*	*Special business*
		01/12/2010	1.25	1.00	*25.0*	*Option 1 (comprehensive water supply fee)*
		01/12/2010	1.17	1.00	*17.0*	*Option 2 (comprehensive water supply fee)*
Public hearing held	Dongguan, Guangdong	2011	1.25	1.17	*6.8*	
		01/12/2010	1.17	1.00	*17.0*	*Option 3 (comprehensive water supply fee)*
		2012	1.28	1.17	*9.4*	
		4Q10	1.61	1.47	*9.5*	*Option 1 (comprehensive water supply fee)*
Public hearing held	Zhongshan, Guangdong	4Q10	1.51	1.47	*2.7*	*Option 2 (comprehensive water supply fee)*
		01/07/2011	1.60	1.51	*6.0*	
		01/07/2012	1.61	1.60	*0.6*	
Public hearing proposed	Nanjing, Jiangsu	4Q10	3.10	2.80	*10.7*	*Residential end user*
Public hearing proposed	Haikou, Hainan	4Q10	NA	NA	*NA*	

Source: BofA Merrill Lynch Global Research

… shutting down inefficient plants …

Discouraging inefficient usage and industries

Other than strengthening control and raising prices, the government has implemented many administrative measures in recent quarters to discourage inefficient usage of energy and other resources, including cutting VAT rebates on exports of high energy consuming and highly polluting products ("Export tax rebate for twin-high products scrapped", 23 Jun 2010), shutting down inefficient capacities ("The greatest capacity closure on earth?", 20 Aug 2010), and restricting finance to offenders ("2,087 enterprises to close obsolete capacities by Sept", 09 August 2010). The government's approach can be quite micro as well. On 1 Jun 2008, it ordered supermarkets to charge for plastic bags.

… and promoting efficient usage and industries.

Encouraging efficient usage & industries

While wielding a stick is important, dangling a carrot is probably more effective. This is where the new strategic industry - Energy Saving & Environmental Protection - largely comes into play. We believe that the government will promote this industry through various means, including tax cuts, more subsidies and better financial support. The rest of this section will focus on the key areas targeted by the government.

High efficiency energy-saving equipment & products

High efficiency energy-saving equipment & products include …

So far the government has not stipulated what constitutes high efficiency energy-saving equipment and products. We suspect this is a very broad term covering any equipment or products that can save significant energy, ranging from large-scale power generator, smart grid to light bulbs. In this report, we choose to focus on high efficiency motors, energy conservation building materials and energy efficient lightings, largely because there are players in the market dedicated to these themes. Of the three, the high end motor industry is the most appealing to us from a top down perspective.

… high efficiency electric motors …

High efficiency electric motors

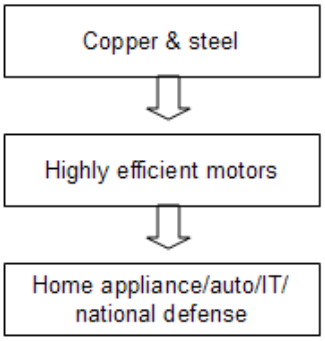
They account for less than 3% of China's total 700mn Kw motor market at the moment, according to China Industry News. China's overall motor energy efficiency is 20% lower than those in most developed countries. The government has targeted to improve motor efficiency since at least late 2006. Table 1.4 lists some of its policy announcements related to the motors.

Table 1.4: Government policies - high efficiency motors

Dec-06	The sales of motors classified as Tier 3 in efficiency will be banned by Jul 1, 2011.
Jun-09	MOF and NDRC subsidized the purchase of high efficiency air-conditioners (using high efficiency motors) for 12 months.
Apr-10	MOF and NDRC extended the subsidy for high efficiency air-conditioner purchase by another 12 months.
Aug-10	MOF and NDRC released a list of high efficiency motor makers and started to grant them subsidies to encourage them to lower selling prices.

Source: various news flows, BofA Merrill Lynch Global Research

Chart 1.5: Value chain – highly efficiency electric motors



Source: BofA Merrill Lynch Global Research

Chart 1.5 shows the industry's value chain. Major global players include Regal-Beloit (US), Emerson (US), A.O. Smith (US) and WEG (Brazil). Table 1.5 contains some key Chinese players. The motor industry is quite fragmented. By 2009, there were around 2,000 Chinese players in this sector with the majority of them being in the low-end segment. Manufacturers generally compete on economy of scale, technology, short response time to customers' request and long-term cooperation with customers.

Table 1.5: Exposures to highly efficiency electric motors

Company	Ticker	Market cap (USD bn)	Market share
Shunde Weilin	Not listed	NA	25-30%
Broad Ocean Motor	002249 CH	1.9	20%
Haier	1169 HK	2.1	13-16%
Wolong Electric Group	600580 CH	1.2	13-16%

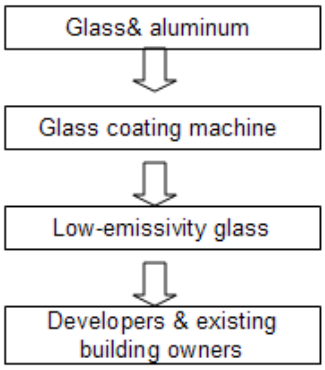
Source: BofA Merrill Lynch Global Research

… energy efficient building materials such as low-E glass gypsum board …

Energy efficient building materials

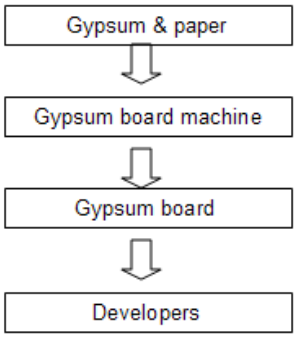
Both President Hu and Premier Wen have called for more energy efficient buildings. Ministry of Housing and Urban-Rural Development (MOHURD) estimated in Nov 2010 that using energy conservation building materials can reduce building related energy consumption by 30%; given that China may build 13bn sqm of buildings over the next ten years, this means a saving of some 100mn tons of coal each year. The way to achieve it, according to MOHURD in 2005, is to require new buildings to use energy-saving materials, and to replace high energy consuming materials in all existing buildings in coastal areas by 2020. Focuses are on heat-conservation windows (low-emissivity glass or "**Low-E glass**") and wall materials (**gypsum board**). So far, low-emissivity glass accounts for about 90% of glass used in Germany and Korea, 75% in Poland, but only 2% in China. Gypsum board usage is also in an early stage adoption in China – China's per capita sales were 2% of US' and 3% of Japan's in 2009. A summary of China's recent policies is in Table 1.6.

Chart 1.6: Value chain – low emissivity glass



Source: BofA Merrill Lynch Global Research

Chart 1.7: Value chain – gypsum board



Source: BofA Merrill Lynch Global Research

... compact fluorescent lamp (CFL) ...

Table 1.6: Government policies - Low-E glass and gypsum board

Sep-05 State Council issued a guidance to support the use of heat conservation building materials.
Jul-05 MOHURD issued a guideline on energy savings of public buildings.
Nov-05 MOHURD issued a guideline on energy savings of civil buildings.
Dec-06 MOHURD required to use heat-conservation materials for windows and walls.
Dec-07 China Building Decoration Industry Association called to use more energy-saving glass.

Source: various news flows, BofA Merrill Lynch Global Research

For **low-emissivity glass**, value chain is shown in Chart 1.6 and key Chinese players in Table 1.7. German manufacturers dominate the glass coating machine segment, including Von Ardenne and Leybold. However, there are few global competitors in the domestic low-emissivity glass manufacturing market given high transportation costs and locals' manufacturing cost advantage. By 2009, there were around 10 meaningful Chinese players in this capital intensive sector (a production line of 1.4mn sqm glass/year can cost Rmb186mn, as in Avic Sanxin's case).

Table 1.7: Exposures to low emissivity glass manufacturing

Company	Ticker	Market cap (USD bn)	Market share
CSG	000012 CH	5.5	50%
Anyuan Industrial	600397 CH	0.7	10-15%
Xinyi Glass	868 HK	2.8	5-8%
Avic Sanxin Co Ltd-A	002163 CH	1.0	5-8%

Source: BofA Merrill Lynch Global Research

For **gypsum board**, Chart 1.7 shows the value chain and Table 1.8, the key Chinese players. The market is featured by low entry barrier and rapid capacity expansion. There are numerous players in both the machine and board sector. Most of the board makers are small, with annual capacity in the range of 2-4mn sqm vs. some 20mn sqm for the large ones.

Table 1.8: Exposures to gypsum board

Company	Ticker	Market cap (USD bn)	Market share
Zhejiang Yankon Group	600261 CH	1.4	10.8%
CNlight	002076 CH	0.3	NA

Source: BofA Merrill Lynch Global Research

Compact fluorescent lamp (CFL)

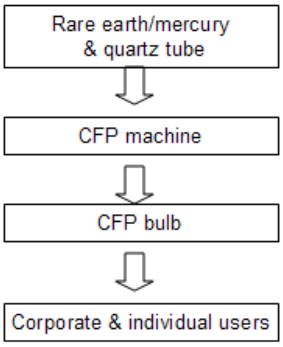
About 12% of China's power consumption is for lighting. A **CFL** can save about 80% power compared to an incandescent bulb, and the government has consistently promoted its use. An effective step was to grant subsidies to CFL makers which helped to cut selling prices by 30% for corporate users and 50% for retailer users (Table 1.9). LED can save even more energy but its application is currently constrained by high cost.

Table 1.9: Government policies - CFL and LED

Sep-96	NDRC launched the Green Light project to promote CFL adoption in 1996-2000. Local governments were allowed to subsidize local makers/users.
2000	NDRC extended the project to 2001-2005.
May-04	MOHURD required local governments to use energy-saving lighting in social service facilities, tourist areas and commercial areas.
Jul-06	NDRC, MOST, MOF and MOHURD announced 10 key projects to save energy in the 11th Five Year plan (2006-2010), which included the Green Light project, i.e. another 5-yr extension.
Jul-06	NDRC required cities to cut street lighting's energy consumption by 5% a year from 2005, for a total cut of 25%. 85% of lamps must be high efficiency ones.
Dec-07	MOF and NDRC started to subsidize the purchase of CFL. (50mn lamps targeted in 2008; the actual - 62mn lamps). Local governments were encouraged to chip-in.
Jan-09	MOF and NDRC continued the CFL purchase subsidy, and raised the target to 100mn a year.
May-09	MOST launched the "10 cities, 10K lamps" project to pilot test the use of LED for street lighting.
Jan-10	MOF and NDRC continued the CFL purchase subsidy, and raised the target to 150mn a year.

Source: various news flows, BofA Merrill Lynch Global Research

Chart 1.8: Value chain - CFL



Source: BofA Merrill Lynch Global Research

For CFLs, the value chain is in Chart 1.8 and key Chinese players, Table 1.10. Domestic makers dominate the making of both CFP machine and bulbs. The industry is characterized by rapid demand growth due to rising public awareness, low entry barrier, rising capacity, and heated competition. China currently accounts for about 80% of CFP global production. However, Chinese products' brand recognition in overseas markets is poor with about 50% of China's output being for OEM orders from foreign companies.

Table 1.10: Exposures to CFP bulb makers

Company	Ticker	Market cap (USD bn)	Market share
Beijing New Building Materials	000786 CH	1.3	28%
Pinyi Zhongxin	Not listed	NA	3-4%
Nanle Jinhua	Not listed	NA	3-4%
Huatai	Not listed	NA	3-4%

Source: BofA Merrill Lynch Global Research

... and LED

LED

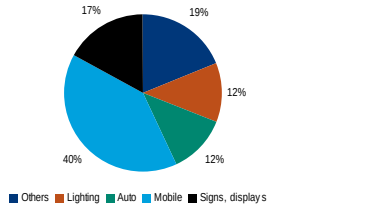
Mobile phone is the largest user of LED at the moment but the TV market will drive its usage over the next few years, likely followed by the lighting industry.

LED is a key area that the government is targeting to save energy. MIIT has set aside Rmb8-10bn subsidy dedicated to the sector (Steven Milunovich, China's Commitment to LEDs, 29 Sep, 2010). In addition, as most LED related companies are recognized as high-tech firms in China, they are entitled to various tax concessions including 50% tax relief on corporate income tax. Moreover, China Securities Regulatory Commission (CSRC) and domestic banks are very supportive of the industry which makes easier for players to obtain financing.

Local governments are also offering very generous subsidies to attract LED firms to set up shops in their areas and many have even built large industrial parks dedicated to LED research and production. For example, Guangdong Province, where some 70% of packaged LED devices in China are made, has committed as much as Rmb2bn a year to its "Guangdong New Light Industrial Base Transformation" program (Steven Milunovich, China Sees Strong LED Demand, 29 Sep).

In recent times, there have been concerns about over capacity in the industry.

Chart 1.9: LED market breakdown, 2010

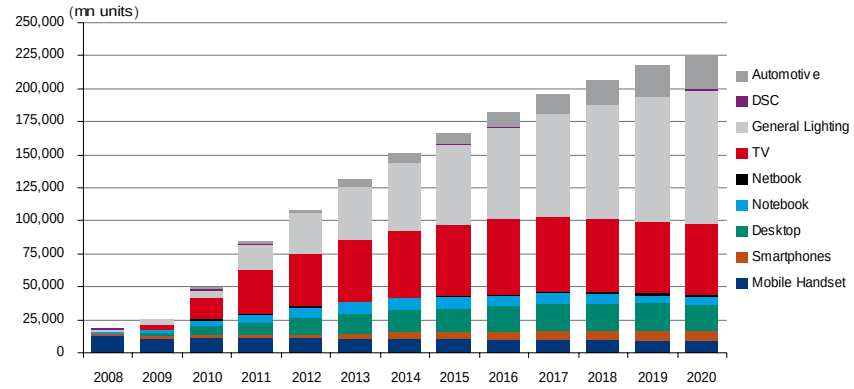


Source: Strategies Unlimited

Market opportunity

LED are used in many areas including mobile devices, automotives, mid-to-large-sized LCD displays (notebook, PC monitor and TV etc.), and general lighting. At the moment, mobile phone and displays account for some 60% of total LED consumption (Chart 1.9). We expect the TV market to be the main driver of LED usage over the next few years, followed by the general lighting market (Chart 1.10, Masashi Kubota, "Quantifying the value added in LED supply chain", 04 Nov 2009).

Chart 1.10: LED demand : growth comes from TV (short term) and general lighting market (long term)

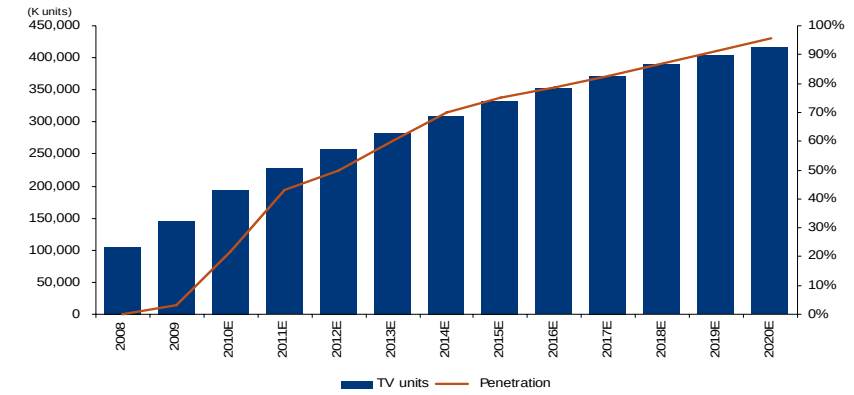


Source: BofA Merrill Lynch Global Research estimates

LED TV BLU (backlit unit): the fastest growing area

Traditionally, mobile phone LED accounted for the largest portion of the LED market (63% in 2008). In 2009, major TV makers started to actively launch LED-based TV which boosted LED demand (Chart 1.11, Simon Woo, "Our top pick among Korean LED plays", 25 Jun 2010).

Chart 1.11: LED penetration in TV - ratio of LED to total LCD TV shipment



Source: BofA Merrill Lynch Global research estimates

General lighting: the long-term growth driver

We believe that the pace of the adoption of LED lighting holds the key to the industry's long term growth outlook after LED-TV demand saturates. Factors currently holding back the widespread adoption of LED lighting include light quality and high initial purchase cost for consumers. Table 1.11 compares the advantages and disadvantages of incandescent, CFL and LED bulbs. Currently,

CFL is a mature technology and much cheaper compared to LED, so likely will remain the dominant energy saving lighting solution in the foreseeable future. But LED has a chance to expand its market share once technology improves and cost comes down because of some of its attractive features such as durability, reliability and high energy efficiency.

Table 1.11: Comparison among 3 main lighting solutions

	LED	CFL	Incandescent
General characteristics			
Lamp price	Expensive	Medium	Cheap
Life span (hours)	Long	Medium	Short
	15,000~40,000	6,000~10,000	1,000~2,000
Conversion efficiency (m/Watt)	High	High	Low
	70~80	57	12
Reliability	High	Medium	Low
Reaction speed	Fast	Slow	Fast
Shortcomings	Expensive	Pollution	Heat, low energy efficiency, short life span
Economics			
Bulb	Philips EnduraLED	Philips Energy Save 12W	Philips 60W Clear
Power rating (W)	12	12	60
Lifetime (hours)	25,000	8,000	1,000
Price (US$)	60 (Estimate)	3	0.49
Electricity cost (US$/Kwh)	0.15	0.15	0.15
Availability	Q4 2010	Now	Now
Discounted cost of ownership (5yr)	67	10	36
Discounted cost of ownership (10yr)	71	15	59
Discounted cost of ownership (25yr)	76	22	87

Source: BofA Merrill Lynch Global Research

Based on our European colleague Jonathan Crossfield's estimates, at an electricity price of US$0.15/Kwh, LED lighting will cost less than incandescent lighting after about 16 years of usage. On the other hand, compact cold fluorescent (CCFL) lighting remains the low-cost solution over any period of ownership considered. A CCFL bulb currently costs around a twentieth of the price of a comparable LED device.

For LED to be widely used, its cost needs to fall significantly or the government has to legislate its usage. Both are likely. The LED lamp being compared here is one of the first commercial 60W equivalent devices and we would expect prices of such devices to fall rapidly as production expands and technology matures. Please note that the comparison here excludes the cost of associated fixtures and fittings. LEDs can be implemented in a highly integrated manner, with minimal maintenance costs. This may prove an additional attraction to consumers.

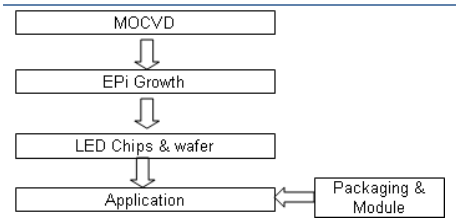
Table 1.12: Schedule to ban incandescent lamps

2009	Ireland
2010	Australia, Argentina, Italy, France
2011	Netherlands, U.K.
2012	Taiwan, Canada
2014	U.S.
2017	China

Source: BofA Merrill Lynch Global Research

Legislation is driving a shift towards more energy efficient lighting solutions. Incandescent lighting emits heat and wastes energy. As a result, many nations have banned the sale of incandescent bulbs (See Table 1.12). China will release a timetable in 2011 to ban them as well (most likely by 2017). This should drive CCFL sales over the next few years. In the long term, it may also help to promote the adoption of LED based general lighting in our opinion.

Chart 1.12: Value chain - LED



Source: BofA Merrill Lynch Global Research

Key players along the value chain (Chart 1.12)

Upstream sectors include equipment vendors such as Metal-organic Chemical Vapor DePosition (MOCVD), wafer and chips; down stream sectors include packaging and application (lighting, TV, mobile phone and etc). Upstream is the bottleneck of the industry at the moment.

Supply of substrate (the material on which crystal is grown in MOCVD) may remain a bottleneck for the industry in the foreseeable future. The market has high entry barriers and is highly concentrated. Currently Nicha (Japan) is the dominant sapphire substrate vendor globally; while Cree (US) is the dominant SiC substrate vendor. Sapphire is the most common technology with over 90% market share currently; SiC is more expensive, but has better performance in many aspects. Two Chinese companies are getting into the substrate sector:

- TDG (600300 CH) invested RMB100mn in a JV (with Japanese partners MAT and KDN) to product 4" sapphire substrate. Production is scheduled in 2011.
- Tianfu Thermoelectric (600509 CH) makes SiC chips with its own proprietary technology.

We expect the bottleneck in wafers to gradually ease over the next few years with significant MOCVD capacity expansions planned both domestically and overseas. Overcapacity in the industry is a possibility if the lighting market does not accelerate as expected.

Competition in downstream packaging and application sectors is intense given low entry barriers. As a result, opportunity here seems more company specific, e.g. those with advantages in end products design or sales channels.

Table 1.13 contains some listed companies with LED exposures.

Table 1.13: Exposures to LED (energy saving lighting)

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
1868 HK	Neo-Neon Holdings	0.5	Decorative lighting	Medium	It makes incandescent/LED decorative lighting and entertainment lighting products.
40 HK	Gold Peak Industries	0.1	LED display screens	High	It makes LED display screens, also electronic products, batteries, and electrical wiring installation products.
CIL US	China Intelligent Lighting	0.04	Lighting	Medium	It provides a full range of lighting solutions. The Company produces LED and other lighting products for household, commercial and outdoor lighting industries in China and internationally.
LED LN	LED International	0.01	LED	High	It sells LED display screens and other LED products used for signs, lamps, lighting and building illumination.
600703 CH	Sanan Optoelectronics	4.6	Wafer, chips	High	A vendor of LED wafer and chips, capable of producing high brightness LED in all colors. The company also has some presence in solar power, i.e. concentrator photovoltaic cells (GaAs); conversion efficiency of its solar products reached 36% in 2009.
600460 CH	Silan Microelectronics	1.5	Wafer, chips, display	High	A semiconductor company. LED contributed to 20%+ of its 2009 revenues.
300102 CH	Xiamen Changelight	1.5	Chips	High	A LED chip vendor. 2009 revenue breakdown: 85% LED, 15% solar. Key product: high brightness red/yellow 4-chip LED. The company's solar wafers (three-junction gallium arsenide) are mainly used in the space industry (i.e. satellites) or concentrator photovoltaic cells.
600363 CH	Lianchuang Optoelectronic	0.7	Packaging	High	Key products include LED optoelectronic devices, optical cable, relays, and acoustic devices. LED contributed to 53% of its 2009 revenue.
002449 CH	Nationstar Optoelectronics	1.4	LED applications	High	It specializes in Surface Mounted Device LED (SMDLED) products, including components, lamps, displays, backlight and decoration. It's expanding upstream (wafers, chips).
002185 CH	Tianshui Huatian Tech	0.8	Packaging, testing	High	LED packaging is its main business.
600509 CH	Tianfu Thermoelectric	1.1	SiC substrate	Medium	It's primarily a power generation company (IPP), located in Xinjiang. Revenue breakdown in 1H2010: power/heat 64%, property 16%, others 20%. It makes SiC chips with proprietary technology. The company currently has 48 SiC growers, with total capacity of 7,000 chips. It may increase its SiC capacity to 300 growers by 2012.
600300 CH	TDG	1.5	Sapphire substrate	Low	A magnetic materials vendor. Key product: ferrite cores.
600100 CH	Tsinghua Tongfang	4.0	Tech conglomerate, chips	Low	A tech conglomerate. The company has a wide range of businesses, including PC, digital city, the Internet of things, microelectronics, multimedia, semiconductor/lighting, internet, defense, digital TV, and environmental. Its LED business is still at the investment stage. Key products planned: LED chips, LED TV, and LTD lighting.
000541 CH	Foshan Electrical and Lighting	2.2	Lighting	Low	China's largest lighting product producer with a broad range of products. The company recently announced plans to enter into the electric car and lithium battery business. It has a 38% stake in a lithium carbonate JV, Qinhai Fozhao Lithium, which formed a 51:49 JV with Qinhai Salt Lake Group to explore the latter's lithium resources. The company plans to acquire a 20% stake in Hefei Guoxuan High-tech, a Li-ion battery cathode material and lithium-ion battery maker. The company also invested in an electric auto JV, which recently announced to test its first electric bus.
600261 CH	Zhejiang Yankon	1.6	Lighting	Low	One of China's largest lighting product producers with a focus on energy efficient lamp.
002076 CH	Cnlight	0.3	Lighting	Low	A professional lighting product producer. Key products are energy efficient lamps, xenon headlamps for cars (HID) and UV Sterdilizers.
600651 CH	Feilo Acoustics	1.1	Lighting	Low	Mainly a lighting product producer. 1H2010 revenue breakdown: lighting 73%, IC 13%, audio products 10%.

Source: BofA Merrill Lynch Global Research

The government wants to promote recycling, including battery recycling.

Key technologies in resources recycling

It appears to us that battery recycling can be one of those unglamorous but highly profitable businesses.

Market opportunity

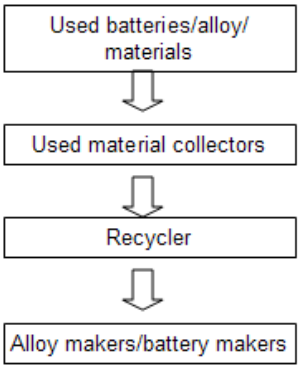
The market is booming for the recycling of cobalt and nickel from used battery/scrap materials. In its 11th Five Year Plan (2005-2010), China targeted to set up a system for non-ferrous metals cycling. In 2007, NDRC encouraged government agencies and SOEs to participate in the recycling of batteries (with cobalt and nickel targeted). China consumes around 1.5bn batteries a year, but only 2% of them are recycled (vs. 98% in developed countries). On the other hand, China relies heavily on imports of cobalt and is also the largest nickel consumer globally.

Table 1.14: Government policies - recycling of used batteries

Dec-04	China published the Laws of Solid Waste Pollution Control, requiring professional recyclers to handle pollutant in solid waste.
Dec-06	The 11th Five Year Plan of Non-ferrous Recycling called to help to expand non-ferrous supply through recycling.
Jan-07	NDRC published a list of 130 high-tech sectors that need strong support, including the recycling of solid waste.
Aug-07	NDRC promoted nationwide recycling of used batteries.
Aug-07	MOC and NDRC promoted resources recycling.
Jan-08	The 11th Five Year Plan of high techs called for the development of technologies for used battery recycling.
Aug-08	China published the Laws of Recycling Economy Development.

Source: BofA Merrill Lynch Global Research

Chart 1.13: Value chain – cobalt & nickel recycling



Source: BofA Merrill Lynch Global Research

Key players (Table 1.15) along the value chain (Chart 1.13)

For the recycling of used batteries/scrap materials, so far none of the major global players are in China as far as we are aware. The industry is characterized by high entry barriers (technology and regulatory), stable margin and high growth potential: few companies have the technology to restore the performance of recycled cobalt and nickel to the same level as raw metals; the government is strict with licensing granting due to concerns over the consequences of any improper treatment; margin is fairly stable as the prices of raw material (used battery/scrap materials) usually move in line with the prices of raw cobalt/nickel; growth potential is abundant as only 15-20% of cobalt and nickel in China were recycled by 2009.

Table 1.15: Exposures to cobalt and nickel recycling

Company	Ticker	Market cap (USD bn)	Market share
Shenzhen Green Eco-Manufacture	002340 CH	1.1	35.7%
Bangpu	Not listed	NA	28.6%
Henyuantai	Not listed	NA	17.9%

Source: BofA Merrill Lynch Global Research

Energy saving & environmental protection service sector

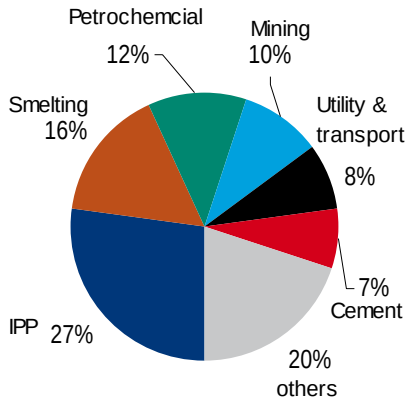
A key energy saving & environmental protection service is EMC.

Market opportunities for energy management contract (EMC) and high-voltage inverter appear significant to us. These two are related. Many EMC providers need to purchase the inverters to conduct their business. Between the two, competition in the EMC business appears less.

Market opportunity

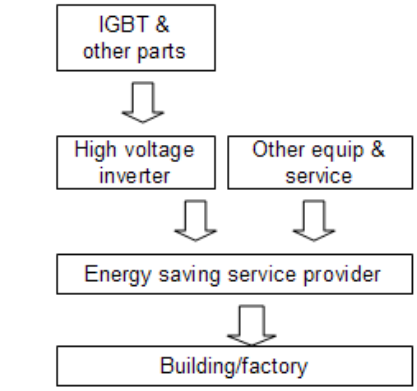
Energy management contract sales reached Rmb58.8bn in 2009 (+40.8% YoY) and the total market opportunity is around Rmb450-600bn, according to China Energy Management Contract Association in Mar 2010. With an EMC contract, a service provider tailor-makes an energy saving solution for a customer, purchases the necessary equipment and software, manages the energy usage of the related equipment/building, and charges a portion of the saved energy expenses from the customer as its fees. The central government has issued several policies to support the development of EMC in recent years (Table 1.16). Many local governments, including those in Shandong, Jiangsu and Henan, have released their own regulations to promote the service.

Chart 1.14: Segment of high-voltage inverter market



Source: Inverter World BofA Merrill Lynch Global Research

Chart 1.15: Value chain – high-voltage inverter & EMC



Source: BofA Merrill Lynch Global Research

Table 1.16: Government policies - EMC

2007	The State Council called to speed up the development of the EMC industry.
2008	The State Council issued a guideline to encourage public service institutes (e.g. schools, museums, hospitals) to adopt the service.
Apr-10	NDRC, MOF, PBOC and SAT promised to support, including 1) tax benefits, e.g. business tax & VAT exemptions and reductions to corporate income tax (3-year exemption, followed by 50% tax cut); 2) better financing channels.
Jun-10	Subsidies from central & local governments to service providers, equivalent to Rmb300 per metric ton of coal saved.
Aug-10	NDRC announced the 1st batch of qualified companies.
Aug-10	NDRC released unified industry standards.

Source: various news flow, BofA Merrill Lynch Global Research

The growth in EMC drives the demand of high-voltage inverter, the key equipment used in EMC. High-voltage inverters allow motors to vary their operation speed to accommodate different workload, thus reduce energy consumption significantly. Its application is often restricted by the high upfront costs – an inverter alone usually costs several million Rmb. That's probably why it's current adoption is concentrated in capex heavy industries (Chart 1.14). EMC allows a company to outsource the upfront costs and only pay when it sees real energy savings and over a long period. Thanks to EMC' growth, the sales of high-voltage inverter surged from Rmb1.7bn in 2007 to Rmb3.9bn in 2009.

Key players along the value chain

The value chain of high voltage inverter and EMC is in Chart 1.15. Other than Insulated Gate Bipolar Transistor (IGBT), China has commoditized the production of most other parts (IGBT usually accounts for less than 10% of high-voltage inverters' price). Chinese players have about 80% market share in the general inverter market. Working voltage of motors in China is 6Kv or 10Kv, different from the 3.3Kv in US, Europe and Japan. As a result, foreign players have to invest significant time/research to adapt their products to China so they generally focus on the high-performance inverter segment which requires more advanced technology. Key market features include high growth potential, capital intensive, low technology entry barrier and emerging competition. We notice that the current industry margin appears thick and has started to decline. Key domestic players are in Table 1.17.

Table 1.17: Exposures to high voltage inverter

Company	Ticker	Market cap (USD bn)	Market share
Leader & Harvest	Not listed	NA	20.50%
Hiconics Drive Technology	300048 CH	1.1	11.50%
Harbin Jiuzhou Electric	300040 CH	0.5	5.00%
Guangzhou Zhiguang Electric	002169 CH	0.6	4.70%
Hubei Tri-Ring	000883 CH	0.5	4.70%
Xinfengguang	Not listed	NA	4.00%
Micro Energy	Not listed	NA	1.50%
Rongxin Power	002123 CH	2.5	1.30%

Source: BofA Merrill Lynch Global Research

A few important Chinese EMC players are listed in Table 1.18. Key industry characteristics include strong demand outlook, relatively high entry barrier (regulation and capital), labor intensity and fairly stable margin (dropped temporarily in 2009 due the financial crisis). Regulatory hurdle is high, as a player needs to get permits first, similar as in construction/design industries. Capital

demand is also high because investment is front loaded while cash inflow is spread over many years. Besides, the business is labor intensive as equipment and software need to be tailored for each customer. Foreign players used to dominate this business but have largely exited by now as a result of their labor cost disadvantage. They are now largely focusing on the supply of equipment and software. Meanwhile, local companies flourished; by 2009, there were 502 companies in this industry. At this stage, they were all relatively small in size - the industry is still in its initial development stage and consolidation hasn't started yet.

Table 1.18: Exposures to EMC

Company	Ticker	Market cap (USD bn)	Market share
Tsinghua Tongfang	300070 CH	2.9	NA
Tellhow Sci-Tech	600590 CH	0.9	NA
Zheda Zhongkong	Not listed	NA	NA
Huitong Huacheng	Not listed	NA	NA

Source: BofA Merrill Lynch Global Research

Advanced environmental protection equipment & products

Advanced environmental protection equipment & products cover those for …

In this section, we will focus on those related to air pollutant, solid waste and water treatments.

Gas treatment

… gas treatment …

The sector includes denitrification, desulfurization and dust removal. Unlike the emission control of SO2, there is no ready technology/company in China to provide the carbon-capture service. China is pilot testing several technologies, for example, one is to capture CO2 from coal-fire power plants and gas fields. So far the research is still government sponsored although private companies may get involved at some point in the future.

Denitrification

Denitrification removes nitrogen oxides from waste gas. It is a new focus of the government:

- Recently, the State Council has required all thermal power plants in Beijing, Tianjin, the Yangtze River Delta & Pear River Delta to complete the installation of denitrator during the 12th Five-Year Plan period (2011-2015).
- The government is revising the "Thermal Power Plant Air Pollutant Emission Standards" and may tighten nitrogen oxide emission standards significantly.
- "Denitrification electricity price" may be introduced, offering higher electricity purchase prices for those power plants that have installed denitrators, similar to the existing "desulfurization electricity tariff".

Roughly 60% of the emission comes from the thermal power industry. Table 1.19 contains some companies with exposure to denitrification.

Table 1.19: Exposures to denitrification

Ticker	Short name	Market cap (US$ bn)	Business	Exposure	More details
556 HK	Pan Asia Env	0.2	Denitrification	Low	Mainly a waste water treatment contractor, with ambitions in BOT. The company has some presence in desulfurization and denitrification business (SCR). Chairman of this company is also the Chairman of China Rare Earth (00769 HK).
600292 CH	Jiulong Electric Power	1.0	Denox/ Desulfurization catalyst	Medium	Power generation and environmental industry are its main businesses with the latter its main earnings driver. 1H2010 revenue breakdown: power 39%, fuel 33%, environmental 30%. On the environmental side, it specializes in desulfurization, denox, nuclear waste treatment, and carbon capture. The company's SCR denox catalyst project has a capacity of 10,000ton/annuam and could become a major profit driver for the company.

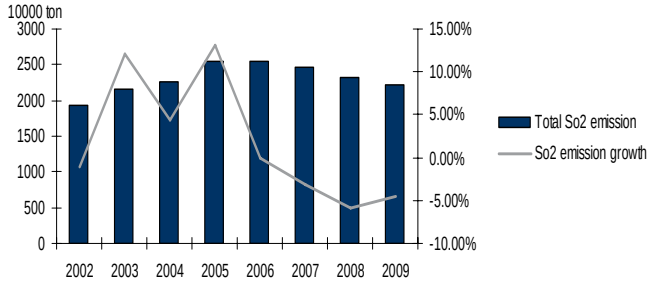
Source: BofA Merrill Lynch Global Research

Desulfurization

The market is saturated. China's sulfur dioxide emission has peaked in 2005 as a result of enhanced emission control efforts (Chart 1.16). In 2009, China had achieved its 11th Five-Year Plan sulfur dioxide reduction targets, 1 year ahead of schedule.

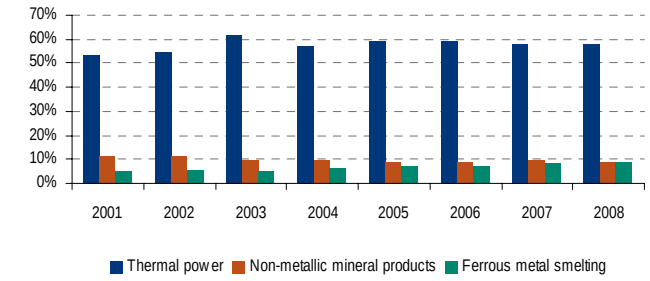
The biggest So2 emission industries include thermal power, non-metallic mineral products, and ferrous metal smelting. Thermal power industry accounts for ~60% of the total emission (Chart 1.17).

Chart 1.16: So2 emission



Source: China Environment Statistic Yearbook 2008; China Environment Official Report 2009, BofA Merrill Lynch

Chart 1.17: Contribution rate of So2 pollution



Source: China Environment Statistic Yearbook 2008, BofA Merrill Lynch Global Research

The demand for desulfurization equipment from the thermal power industry has shrunk in recent years because of high penetration rate (66% in 2008, 80% by 2010) and poor profitability at IPPs.

The metals (steel, non-ferrous) industry is the 2nd largest source of sulfur dioxide emission in China. The steel industry is a big source, especially steel sintering, which accounts for over 60% of the total emission from the metals industry. But the demand for desulfurization equipment looks unexciting here as well, partly because of the government's drive to shut down backward capacities.

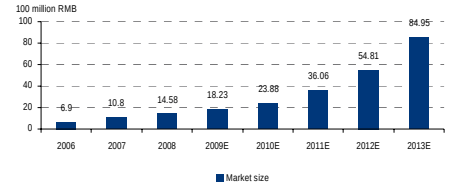
Table 1.20 shows a list of companies that are exposed to the desulfurization industry.

Table 1.20: Exposures to desulfurization

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
300072 CH	Beijing SJ Env Protection	0.7	Desulfurization catalyst	High	A producer of desulfurization catalysts/agents. Its products are widely used in refineries, chemical plants, gas desulfurization, coal chemical industry, and the fertilizer industry. The company is a key beneficiary of higher auto emission standards.
000915 CH	Shanda Wit Sc& Tech	0.5	Desulfurization	Low	A conglomerate. 1H2010 revenue breakdown: pharmaceutical 66%, environmental 10%, education 9%. The company's key environmental product is chlorine dioxide purification equipment.
002149 CH	Western Metal Materials	0.7	Materials	Medium	A special materials maker. 2009 profits breakdown: rare earth metals composite materials 51%, titanium 21%, metal fibers and products 12%, refractory and precious metal products 13%. Titanium/steel plate, a key product of the company, is used in desulfurization equipment and as anti-rot materials. The company is also a large titanium maker. Refractory and precious metal products can be used in the nuclear industry.
600292 CH	Jiulong Electric Power	1.0	Denox/ Desulfurization catalyst	High	As above.
600133 CH	East Lake High Tech	0.7	Property, desulfurization, waste treatment	Medium	Primarily an industrial park. 1H2010 revenue breakdown: property 51%, science& technology industrial park 10%, desulfurization 18%, chromium slag treatment 22%. Its desulfurization subsidiary is a third party desulfurization service provider (BOOM projects). The company's chromium slag treatment subsidiary is a environmental power generation company that uses its power generators to detoxify chromium slag. The subsidiary is currently loss making, reasons: 1) high coal prices; 2) equipment more costly than conventional power plants; 3) burning chromium slag does not product heat, on the contrary, it absorbs heat. The company is lobbying the government for favorable policies.

Source: BofA Merrill Lynch Global Research

Chart 1.18: Market size of high temperature filter



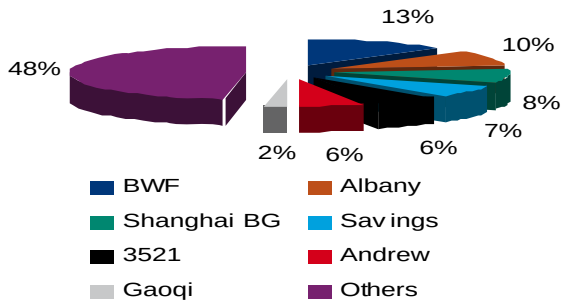
Source: Dust Removal Association, "Chinese high-temperature filter materials market research report", May 2009; BofA Merrill Lynch Global Research

Dust removal

Similar to desulfurization industry, the dust removal/filter market is saturated. Most of coal-fire power plants, cement maker and steel mills have been equipped. The thermal power market for dust removal is very concentrated with BWF, Albany and Xiamen Savings (300056 CH) accounting for ~60% total market share (Chart 1.20).

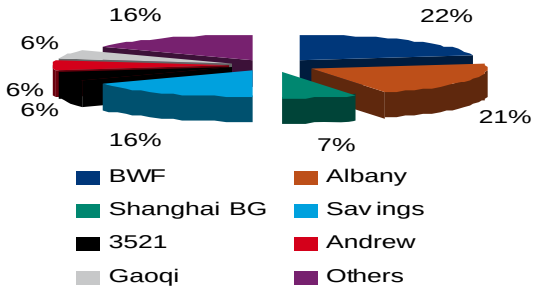
One popular way to remove dust is through fiber filters, usually a bag or a membrane made from polyester, fiberglass, nylon or cotton. The high-temperature filter industry is fragmented (Chart 1.19). Xiamen Savings and most foreign brands mainly focus on the high-temperature synthetic fiber filter market which has a relative high entry barrier. Most other domestic vendors focus on low-end glass fiber filters.

Chart 1.19: Market share of domestic high-temperature filter market 2008



Source: Filter Authority, "Chinese high-temperature filter materials market research report", May 2009; BofA Merrill Lynch Global Research

Chart 1.20: Market share of power generation filter market 2008



Source: Filter Authority, "Chinese high-temperature filter materials market research report", May 2009; BofA Merrill Lynch Global Research

Another often used way to remove dust is by using electrofilters which remove particles, dust, or flying ash from a flowing gas by the force of an induced electrostatic charge. Both methods can be used in power plants.

Table 1.21 lists companies with exposure to dust removal.

Table 1.21: Exposures to dust removal players

Ticker	Short name	Market cap (US$ bn)	Business	Exposure	More details
300056 CH	Xiamen Savings	0.3	Fabric dust collector	High	High temperature faber filter media for industrial dust collectors. IPP is the most important client (~70% of its revenues). Other users include cement, garbage power, and metal smelters.
600388 CH	Fujian Longking	1.1	Electrofilter	High	An electrofilter and desulfurization equipment vendor. The company's equipment is widely used in IPPs, cement, and metals industries. 1H2010 revenue breakdown: 65% electrofilter, 23% desulfurization equipment.
600526 CH	Zhejiang Feida Env	0.3	Electrofilter	High	An electrofilter and desulfurization equipment vendor. The company's equipment is widely used in IPPs, cement, and metals industries. 1H2010 revenue breakdown: 69% electrofilter, 10% desulfurization equipment.

Source: BofA Merrill Lynch Global Research

Carbon capture

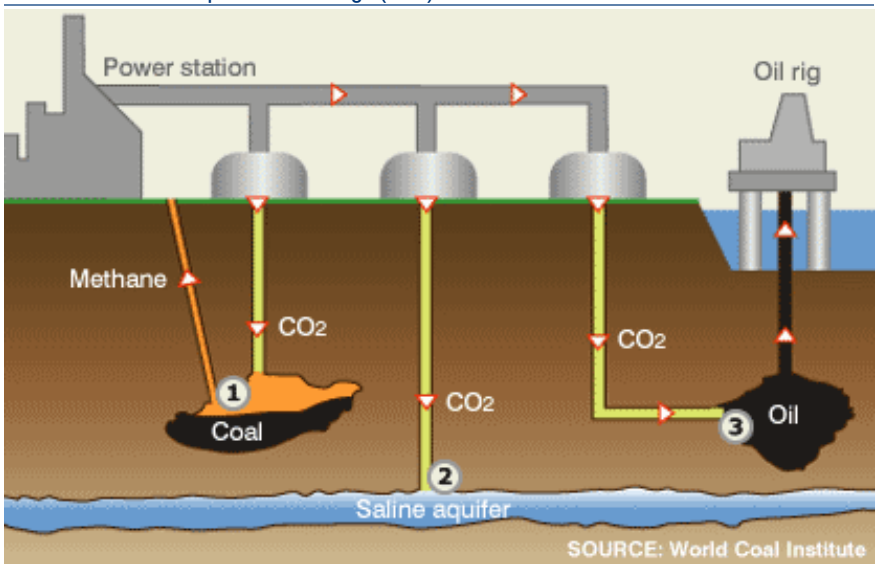
As stated earlier, China plans to cut CO2 emission per unit GDP by 40-45% from the 2005 level before 2015. China currently only has SO2 and COD emission controls but will add CO2 to the list in 2011. A proposal on carbon tax (at Rmb10/ton) was announced on Dec 10, 2010 with a launch possible in 2011. Importantly, the draft specifies that the tax revenue will go to local governments which should promote enforcement.

Carbon capture and storage (CCS) is a technology that can significantly reduce CO2 emissions from power plants, steel/cement plants, refineries, natural gas processing and etc. The technology is still at an early stage, and there are many challenges:

- High cost: based on a study by Harvard University, the cost can be Rmb100-150/ton of CO2 captured (storage cost not included), which means a cost increase of Rmb0.1/kwh for thermal power.
- Uncertainty of geological storage limit, and reliability
- A reduction of power generation efficiency, by about 20-30%. That means more coal has to be burned.

World Business Council on Sustainable Development said that commercial implementation is not expected for another 20 years. The International Energy Agency is calling for more research/support for the technology, in an effort to control global warming.

Chart 1.21: Carbon capture and storage (CCS)



Source: World coal Institute, BofA Merrill Lynch Global Research

1. CO2 pumped into disused coal fields displaces methane which can be used as fuel
2. CO2 can be pumped into and stored safely in saline aquifers
3. CO2 pumped into oil fields helps maintain pressure and enhance oil recovery with long term CO2 storage in rock formation.

Huaneng Group is actively doing research in the technology. The first carbon capture demonstration project was located in Beijing Gaobeidian with a capture capacity of 3,000 tons/annum. The 2nd project, with a 100,000 tons/annum capacity, is expected to be completed by 2010 in Shanghai. But these demonstration projects are only designed to capture carbon, not store it; the captured CO2 can be commercially sold to carbon users such as beverage companies (to produce soda).

In June 2010, Shenhua said it would start operating the country's first CCS plant by the end of 2010 in Ordos City. The Rmb210mn project is expected to capture 100,000 tons of CO2 annually at an estimated cost of $US50/ton. The company stated that it is planning another facility capable of handling 3mn tons of CO2, but no timetable was provided.

Tianyi Science & Tech has some exposure to carbon capture (Table 1.22).

Table 1.22: Exposure to carbon capture

Ticker	Short name	Business	Market cap (USD bn)	Exposure	More details
600378 CH	Tianyi Science&Tech	Carbon capture	0.7	Low	A gas purification equipment vendor. Key product is pressure swing absorber (PSA), with a 40-50% market share, used to separate one gas from another, e.g. CO2 purification, CO purification, CO2 recycling. The company also makes chemical catalysts, equipment for coal gasification + purification (to produce hydrogen), and "methanol to DME" equipment (with 80%+ domestic market share in 100,000+ ton equipment).

Source: BofA Merrill Lynch Global Research

... solid waste treatment ...

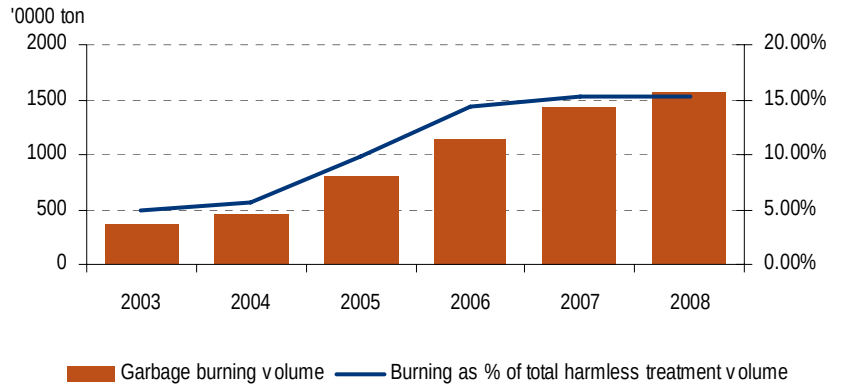
Municipal Solid Waste (MSW) treatment

The focus is on power generation from garbage incineration and landfill. For details of the latter, please refer to the "New Energy – Bio-mass" section of this report.

Market opportunities

As China's metropolises swell and consumer spending grows, the country is now the world's largest producer of household waste. In China, the main way to dispose urban garbage is still landfill, which covers a large area and is causing soil and groundwater pollution due to poor anti-leakage efforts. Roughly two-thirds of cities in China are now surrounded by garbage and landfill is rapidly running out of space.

Chart 1.22: The proportion of waste incineration in China is increasing



Source: Bureau of Statistics of China, BofA Merrill Lynch Global Research

Incineration has rapidly become a main method of garbage disposal in many countries in recent years. The proportion of garbage incinerated in China also rose sharply from 3.60% in 2002 to 15.23% in 2008 (Chart 1.22). In a country like China where land and energy resources are poor, waste incineration for power is ideal – it's environmentally friendly and energy efficient. China's 11th Five-Year Plan (2005-2010) lists waste-to-power as a way to produce renewable energy.

Government policies

There has been a lengthy debate in China on whether garbage incineration is safe for human because the combustion process generates a highly toxic chemical called dioxin which can cause ills, including cancer. According to the World Health Organization, there is a level of exposure to dioxin below which cancer risk would be negligible. But many people remain skeptical, especially in China where the discharge standard is looser - no more than 1 nanogram of dioxin per cubic meter, which is ten times of the amount set in the EU. In addition,

garbage in China has much more kitchen waste, containing a larger amount of moisture. To minimize dioxin, it's critical to keep temperature in the incinerator above 850˚C. As a result, operators have to add coal or diesel for the extra heat, which costs more.

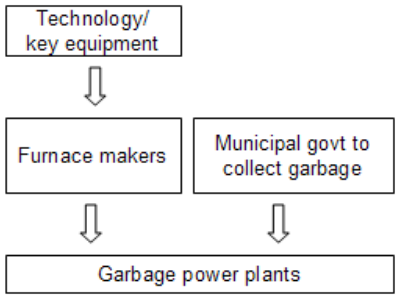
Despite the debate, it appears that the government has decided to push ahead with garbage incineration. 21st Century Business Herald reported on Jan 4, 2011 that the government will soon release a guideline on MSW treatment. Under the guideline, local officials will be evaluated for their performance in this area.

Garbage power officially belongs to renewable energy, thus eligible for tax credits, tariff subsidies and other preferential policies including:

- Preferential tariff: local benchmark price of desulfurized coal electricity plus Rmb0.35/Kwh tariff subsidy (same as biomass power);
- VAT exemption plus Income tax concessions;
- Guaranteed 100% off-take by the grid for the electricity generated;
- Garbage disposal subsidies.

Given public concerns and oppositions against garbage power generation, we expect the government to strictly supervise and enforce its discharge standards and potentially tighten them.

Chart 1.23: Value chain – solid waste treatment



Source: BofA Merrill Lynch Global Research

Key players (Table 1.23) along the value chain (Chart 1.23)

Urged on by the government, the industry is undergoing rapidly growth. In 2010 alone, 41 garbage power plants were scheduled to come on line vs. a total of 56 plants in 2008. Along the industry chain, the upstream equipment supply is a bottleneck in China which heavily depends on imports.

There are two major types of Incinerator: CFB (Circulating Fluidized Bed Boiler Furnace) and Grate Furnace. The advantages and disadvantages between these two are contained in Table 1.23.

Table 1.23: Comparison between circulating fluidized bed boiler furnace and grate furnace

Type	CFB	Grate furnace
Technical basis	CFB Boiler, fluidized bed incinerator	Grate
Energy savings	Coal needed as combustion improver	No combustion improver needed
Requirements for waste collection	High (waste needs to be crushed and dehydrated)	Low
Assist device	Complex desulphurization and dust recovery unit to be added	No need
Operation complexity	High	Low
The results of waste incineration	Inadequate	Adequate
Full load operating time	Short	Long
Pollution	Dusty and greatly polluting the environment	Less dusty, producing some dioxins during on/off process
Cost of construction	Low	High (2-3 times as the cost of CFB)

Source: BofA Merrill Lynch Global Research

In China, Wuxi Huaguang (600475) dominates the domestic CFB market with about 40% of the market share. Currently, there is no large-scale domestic grate furnace business due to technical complexity and high investment costs. Table 1.24 lists some companies with exposure to the MSW treatment sector.

Table 1.24: Exposures to MSW treatment sector

Ticker	Short name	Business	Market cap (USD bn)	Exposure	More details
351 HK	Asia Energy Logistics	Garbage power	0.2	High	Its business includes waste incineration power generation, railway construction and operations.
923 HK	Fook Woo Group	Paper recycling	0.9	High	The company collects and recycles paper, provides confidential paper document destruction services, and manufactures tissue paper from waste paper. it operates in Hong Kong and mainland China.
3989 HK	New Environmental Energy	Garbage power	0.09	High	Waste-to-energy technology, waste treatment.
8230 HK	Shenzhen Dongjiang Env	Waste recycling	N/A	High	It collects, detoxifies, and recycles industrial wastes and sells recycled products. It also provides and implements EP (Environmental Protection) construction services and EP-related consultation services. In addition, it trades chemical products.
CIWT US	China Industrial Waste	Industrial wastewater treatment	0.03	High	The company is engaged in the collection, treatment, disposal and recycling of industrial wastes, municipal sludge and waste water treatment, and environmental protection engineer services principally in Dalian and its surrounding areas in Liaoning Province, China.
CNGI SP	C&G Env Protection	Solid Waste/ sewage treatment	0.2	High	It develops and operates waste-to-energy plants in China. The Company specializes in environmental preservation projects including MSW and sewage treatment.
CHEN SP	China Enersave	Waste reduction, land fill	0.02	High	It builds/operates renewable energy plants in Asia. The company provides environmentally friendly plants that cut waste volume and reduce emission.
ZHL SP	Zhonghui	Waste management	0.002	High	It provides waste management system solutions.
000826 CH	Sound Env	Waste treatment engineering	2.1	High	A solid waste treatment company with main revenue source being solid waste landfill. It also has waste water treatment and water supply businesses. The company is doing research on garbage power generation. Its parentco is one of China's largest private environmental companies. It has a sister company listed in Singapore (SGL SP), which specializes in water treatment.
600649 CH	Shanghai Chengtou	Garbage power	2.8	Medium	1H2010 revenue breakdown: property 46%, water 26%, oil distribution 13%, waste treatment 10%. The company is a leader in garbage power generation in China.
600323 CH	Nanhai Dev	Garbage power	0.7	Low	1H2010 revenue breakdown: tap water 81%, sewage treatment 10%, garbage power 5%. Located in Foshan city of Guangdong Province. Currently, the company has total waste water treatment capacity of 230k ton/day which may soon double. It also has waste treatment capacity of 400ton/day, and its capacity may reach 3,000tons/day by the end of 2012.

Source: BofA Merrill Lynch Global Research

… and water treatment.

Water treatment

The most common waste water treatment solution is membrane filtration. For details, please refer to the “New Materials – High-performance Membrane.” Section.

Table 1.25 lists companies with exposure to water treatment.

Table 1.25: Exposures to water treatment

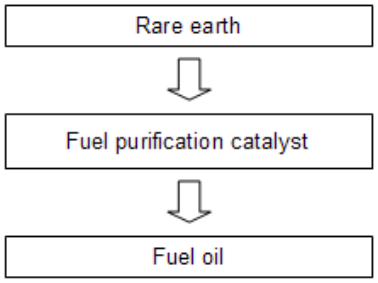
Ticker	Short name	Business	Market cap (USD bn)	Exposure	More details
840 HK	Tianye Water Saving Irrigation	Efficient irrigation system	0.08	High	High efficiency irrigation system and equipment.
371 HK	Beijing Ent Water Group	Water treatment plants construction, water treatment and distribution	1.9	High	Waste water treatment is its core business. Engaged in the construction of sewage and water treatment plants, waste water treatment, water treatment and distribution. Beijing Enterprise is its parent.
DGW US	Duoyuan Global Water	Household water treatment	0.3	High	Water treatment equipment supplier for filtration, water softening, water sediment separation, aeration, disinfection and reverse osmosis etc.
SINE SP	Sino-Environment	Wastewater treatment	0.04	High	The company offers industrial and municipal waste water treatment services. It also treats and manages industrial waste gas.
380 HK	China Pipe Group	Pipes	0.08	Low	It provides a wide range of water pipes, fittings and other related construction materials.
SPIP SP	Sinopipe	Pipes	0.04	Low	It makes plastic pipe and fittings used in drainage and sewerage, water supply, telecommunications, irrigation, and fuel gas sectors.
FZPI SP	Zhenyun Plastics	Pipes	0.03	Low	Plastic pipes for water, communications, gas, and electrical cable.
1130 HK	China Environmental Resources	Animal waste treatment	0.06	Low	Forestry and animal waste treatment. The Company plants fast-growing/ high-yield trees, also markets a machine that uses micro-organisms and heat to convert manure to fertilizer.
600874 CH	Tianjin Capital Env	Wastewater treatment	1.3	High	The company builds and operates waste water treatment plants.
601158 CH	Chongqing Water	Wastewater treatment	6.1	High	An integrated waste water treatment company based in Chongqing. 1H10 revenue breakdown: waste water treatment 64%, water supply 22%, construction 7%.
900935 CH	Shanghai Young Sun	Wastewater treatment	0.3	High	A waste water treatment company based in Shanghai.
000544 CH	Zhongyuan Env-Protection	Wastewater treatment	0.5	High	1H2010 revenue breakdown: waste water treatment 45%, heat production 49%. Waste waster treatment is its main profit source. The company is based in Zhengzhou, Henan Province. It is trying to expand into other regions.
000598 CH	Xingrong Inv	Wastewater treatment	1.5	High	A waste water treatment company based in Chengdu, Sichuan Province.
300070 CH	Originwater Tech	Wastewater treatment: MBR	2.8	High	A sewage treatment technology (MBR) vendor. The Company's services include sewage treatment plant construction and design, equipment integration solution, and technical support services.
300055 CH	Water Business Doctor	Industrial wastewater treatment	2.3	High	Mainly for PetroChina and Shenhua
257 HK	China Everbright Intl	Waste water/solid waste	2.0	High	A waste water and solid waste treatment company. Main businesses: garbage power, waste water treatment, biobass power, solar farms, and wind farms.
1065 HK	Tianjin Capital Env Protection	Designs/ manages water treatment plants	1.3	High	A waste water treatment company based in Tianjin. It designs and manages waste water treatment plants and provides technological consultation. It owns waste water treatment operations in Tianjin.
556 HK	Pan Asia Env	Waste water treatment contractor	0.02	High	Mainly a waste water treatment contractor, expanding into BOT. The company has some presence in desulfurization and denitrification business (SCR).
CHWG US	China Water Group	Waste water engineering and bottle water company	0.004	High	The Company provides turn-key waste water treatment engineering design and contracting. Its customers include municipal governments, food processing and beverage companies, and industrial companies.
TRIT US	Tri-Tech	Water monitor, waste water treatment	0.09	High	Works with local governments in China to design and implement systems to monitor and manage natural and municipal water resources. The company also designs sewage treatment and odor control systems for municipal supplies.
RINO US	RINO Intl	Wastewater treatment equipment	0.1	High	Produces waste water treatment, desulphurization equipment, and high temperature anti-oxidation systems for iron and steel manufacturers.
CLWT US	Euro Tech	Water treatment equipment	0.01	High	Distributor of advanced water treatment equipment (including chlorination equipment) laboratory instruments, analyzers, test kits and related supplies.
GFRE US	Gulf Resources	Wastewater processing chemicals	0.4	Low	Manufactures chemical products for use in oil and gas field explorations, oil and gas distribution, oil field drilling, wastewater processing, and papermaking chemical agents.
SGL SP	Sound Global	Water and wastewater treatment	0.8	High	Provides water and waste water treatment solutions in China, also runs BOT projects. The parentco is one of China's largest private environmental company. It has a sister company listed in the A share market (000826 CH), which specializes in solid waste treatment.
HYF SP	Hyflux	Membrane filtration	1.6	High	A water treatment specialist providing integrated treatment systems for advanced water treatment and membrane filtration. Customers include those in electronics, pharmaceuticals and biotechnology.
DWT SP	Darco Water Tech	Water system engineering	0.02	High	Water system engineering, water management services, trading and supplying chemicals, instruments, electrical controls and other apparatus used in water treatment systems.
SINO SP	Sinomem	Membrane technology	0.2	High	It provides integrated process and engineering solutions for separation, purification and cleaner production purposes in diverse industries including pharmaceutical, chemical and dyestuff, food and beverage, water and waste water treatment industries.

Table 1.25: Exposures to water treatment

Ticker	Short name	Business	Market cap (USD bn)	Exposure	More details
UENV SP	United Envirotech	Environmental solutions	0.2	High	A comprehensive environmental solutions provider, providing both environmental engineering and environmental consultancy solutions to a wide range of customer in the chemical, petrochemical, pharmaceutical, wastewater treatment, food & beverage and textile & dyestuff industries.
BIOT SP	Bio-Treat	Biotech for wastewater treatment	0.07	High	BMS Biological Process Technology for waste water treatment.
AENV SP	Asia Env	Contractor, BOT	0.08	High	Water and wastewater treatment, contactor, BOT. Turnkey projects account for the major part of its revenue.
AWT SP	Asia Water	Water treatment	0.1	High	Wastewater treatment, water purification. The company procures and installs industrial and municipal wastewater treatment systems, and designs and installs water purification treatment systems. Asia Water also designs and implements automated control systems for power plants and wastewater treatment plants.
1412 JP	China Boqi Env Solutions	Contractor, engineering	0.1	High	It provides fuel gas desulphurization & denitration system.

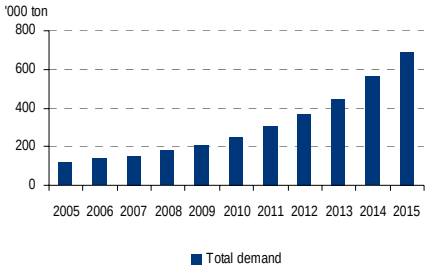
Source: BofA Merrill Lynch Global Research

Chart 1.24: Value chain – fuel purification



Source: BofA Merrill Lynch Global Research

Chart 1.25: Fuel purification products demand



Source: Beijing SJ Env Protection prospectus, BofA Merrill Lynch Global Research

Clean coal initiatives include coal-to-fuel, ...

Fuel purification

Many catalysts/reagents are added to fuel oil and natural gas to reduce emission of sulfur and other harmful substances. They are largely rare earth based (Chart 1.24).

The Chinese government requires energy be purified to reduce sulfur emission (Chart 1.25). Recently, the government raised the domestic fuel oil standards. The new standards require that the sulfur content in diesel must be reduced to 0.035% (vs. 0.2% previously). More stringent standards are expected to be introduced over the next few years.

The main domestic players in the industry include Beijing SJ Env Protection (300072 CH), Northwest Institute of Chemical, Sinopec Changling Catalysts, PetroChina Fushun Petrochemical, Haiso Technology, Shangdong Gongquan Chemical and Wenzhou Huahua.

Overseas competitors include UOP, Albemarle, Süd-Chemie AG, Chevron Corporation, Johnson Matthey and Criterion Catalysts.

Clean coal

The sector covers coal-to-fuel, coal bed methane (CBM), and coal-to-gas.

Coal-to-fuel

Coal-to-diesel is currently being trialed in China, with Shenhua, Yanzhou, Lu'an and Yitai as key participants. Shenhua, Lu'an and Yitai have already started production. For technology, Shenhua uses the direct method from the US. Lu'an and Yitai use the indirect method, a technology developed by China Science Academy. Between the two, direct method usually generates more liquefied oil with low coal consumption, but it requires relatively harsh reaction conditions, e.g. high temperature and high liquefaction pressure.

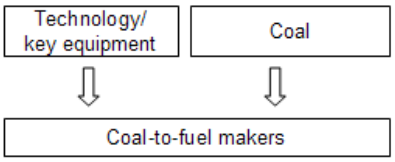
The breakeven price of crude for Chinese makers is about US$40/bbl, according to Shenhua. This explains the enthusiasm of the coal miners and local governments on this technology. According to Shenhua, its plant needs 3.3 tons of coal to produce 1 ton of diesel; byproducts are naphtha (~20%) and gas (10%).

Government policies

Local governments and coal miners are most excited about coal-to-oil projects, but the central government has reservations. According to China Energy, quoting an unnamed NBE official, there is still a lot of room to improve energy efficiency and coal-oil conversion rate, although Yitai has made a breakthrough with the indirect method. In Sep 2008, NDRC warned about the risks in the coal-to-diesel industry, citing technology uncertainties, huge investment, and lack of experience. Only Shenhua was allowed to proceed with its pilot-test project, all other projects were suspended. The government's caution then is understandable, i.e. at the height of the global financial crisis, crude oil price crashed while domestic coal price remained relatively high.

Water consumption can be a potential problem for the industry. Shenhua said ~7 tons of water is needed to produce 1 ton of diesel at its project. Yitai needs ~12 tons, while Ningxia/Sasol project needs 6-8 tons. Shenhua pumps water from an adjacent underground lake, which can last for 30 years according to the company's estimate. Whether the industry is consuming too much water? Mr. Zhang Yuzuo, deputy general manager of Shenhua's coal-to-diesel subsidiary, didn't think so. Zhang said that China needs to consume 127 cbm of water for per Rmb10,000 GDP, while Shenhua's project only needs 12 cbm to generate as much.

Chart 1.26: Value chain – coal-to-fuel



Source: BofA Merrill Lynch Global Research

Shenhua invested Rmb12.6bn in Phase-I of its coal-to-diesel project. Phase-I has an annual capacity of 1mn tons of diesel. The project can reach 5mn tons annual capacity when all three phases are completed. Per ton capex is expected to be lower in Phase-II and Phase-III as infrastructure has already been built.

Coal bed methane (CBM)

Exhibit 2: Coal bed methane

Source: BofA Merrill Lynch Global Research

Market opportunity

… coal bed methane (CBM) …

CBM can be used for industrial and residential purposes. If CBM is extracted from coal mines, the risk of mine blast is lowered. Green house effect of CBM is 21x that of CO2 if it's directly discharged into the atmosphere, so CBM mining is very good for environmental protection. For residential use, CBM is safer than natural gas or LPG. Because methane is much lighter than the air, it's easily diluted in the house if there is a leakage.

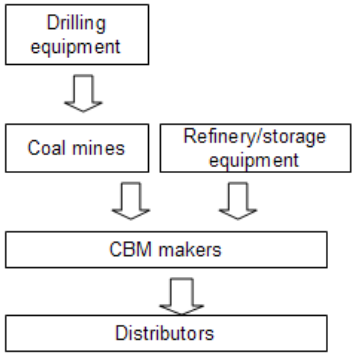
CBM can be extracted from the existing coal mines using special equipments, or drained from unexplored coal mines by drilling. US are most experienced in CBM mining. China's CBM mining is not very successful so far given low gas permeability of most of its coal mines.

Global CBM reserves (<2000 meters deep) is estimated at 240tr cbm, more than natural gas reserves. China has 37tr cbm estimated reserves, ranking the third globally. By the end of 2007, China's proven reserves reached 134bn cbm.

China's coal mines discharges some 10-20bn cbm of CBM a year. This is not a small number, considering that China's total natural gas consumption was just 90bn cbm in 2009. China extracted 4.7bn cbm CBM in 2007, but only 1.4bn cbm was made use of and the rest was discharged. According to NBE, China CBM extraction capacity reached 7.1bn cbm in 2009, of which, ~1bn cbm was from drilling. According to Wood Mackenzie, China targeted 5bn cbm CBM capacity by 2010 (drilling), so the country only achieved less than 1/4 of this target so far. Currently, the government targets a total capacity of 10bn cbm by 2015. According to ZYgas, citing an industry expert, China may significantly increase this target.

Key players along the value chain

Chart 1.27: Value chain - CBM



Source: BofA Merrill Lynch Global Research

The industry value chain is shown in Chart 1.27. Domestic players dominate the market given their access to coal mines and distributors. Foreign players are also very active with their rich experience, e.g. BP and Shell. Due to the heavy investment required in drilling, refining and storage, economy of scale is the key. However, coal mines in China are often independently owned/operated, which makes it difficult to set up a consolidated system.

Large oil companies like PetroChina and Sinopec all have ambitious CBM mining targets; if they can achieve these targets, CBM can become a meaningful growth driver for their gas division (in addition to natural gas). Please note that some of these targets mentioned below are not pure CBM; they may be referring to CBM + underground coal gasification. According to Mr. Li Jingming, chief geography engineer of PetroChina, the company targets 10bn cbm capacity by 2020. For comparison, its natural gas production was 68.3 bn cbm in 2009. China United Coalbed Methane, a CBM miner set up by PetroChina and some coal miners, targets another 10bn cbm capacity by 2020, according to Wood Mackenzie. Sinopec plans to build 2.5cbm capacity by 2015 vs. 8.5bn cbm natural gas production in 2009, again according to Wood Mackenzie.

Gas utility companies are also very interested in the CBM business. So far, HK China Gas (Adding coal bed methane projects, 25 Jan 2010, Angello Chan), ENN Energy (XinAo Gas, Does name change imply risk profile change and overhang?, 25 May 2010, Angello Chan), Green Dragon, Enviro Energy, Zhengzhou Gas, and Far East Energy all have presence in this area.

Coal gasification

... and coal gasification.

With this technology, underground coal will be converted into raw gas under certain temperatures, and then used by the likes of IPPs, chemical industry and household. As stated earlier, sometimes, people may combine CBM and coal gasification when they talk about CBM targets.

Market opportunity

The market is still in its infancy. Potential demand is huge, given China is rich in coal resources and relies heavily on oil and gas imports.

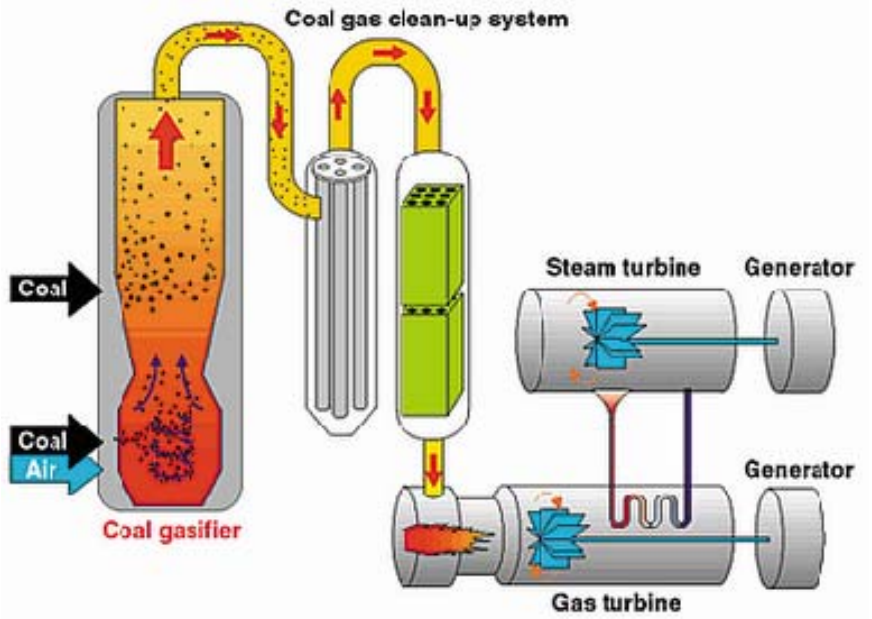
The most promising technology appears to be Integrated Gasification Combined Cycle (IGCC) which is still at the commercial testing phase. IGCC is cleaner than most other alternative methods. It turns coal into synthesis gas (syngas), then removes impurities to reduce emissions, and converts pollutants into re-usable byproducts; heat generated during the process is used for power generation. The system converts coal into cleaner fuel and electricity, saving up to 50% water compared to conventional technologies. IGCC also makes carbon capture easier. Theoretically, almost all CO2 can be captured in the IGCC system. But storage is an issue as mentioned earlier.

Government policies

According to the White Paper 'China's Climate Change Policies and Actions', China will further promote the use of clean coal and clean power generation technologies, such as IGCC and carbon capture and storage technology (CCS). IGCC is also listed as a high priority item in the "Mid-long term Scientific and Technological Development Plan 2006-2020". We expect more policy incentives (subsidies, tax relief and etc) to be introduced to accelerate its development. But large scale commercial application may take some time.

Key players along the value chain (Exhibit 1.2)

Exhibit 1.2: Value chain – IGCC



Source: Center for Environment, Commerce & Energy, BofA Merrill Lynch Global Research

The listed companies with IGCC exposure include Shanghai Electric (601727 CH), a domestic leader in IGCC power generation technology, Keda Industrial (600499 CH), whose IGCC project attracted Rmb35mn central government subsidy, Huaneng Power (600011 CH), whose demonstration project in Tianjin was approved in May 2009, Dongfang Electric (600875 CH), and Guodian Nanjing Automation (600268 CH).

New Generation IT

New generation IT covers …

Under the new generation IT banner, the State Council's announcement specifically targets to enhance IT infrastructure construction; push forward with the development of new generation mobile communication, new generation internet technology, and smart terminals; accelerate the integration of three networks (telecom, cable and internet); promote the development of the "Internet of things" and cloud computing; develop integrated circuit, new display technology, high-end software, and high-end servers; enhance software and internet service capabilities; develop virtual digital technology, and promote the development of cultural and creative industries (Table 2.1).

Table 2.1: New generation IT sector overview

Targeted areas	Policies	Relevant stocks
Three network integration (三网融合)	Tax concessions (including those on VAT and corporate tax); Subsidies in R&D, and equipment purchase; Preferred tenders for government purchases; Government support to Industry consolidation and standard setting.	CMMB Vision (471 HK), DVN (500 HK), Leshi Internet Info (300104 CH), Gehua CATV (600037 CH), Shenzhen Topway Video (002238 CH), Shenzhen Coship Electronics (002052 CH), Chengdu Geeya Technology (300028 CH) Shenzhen Invengo Info (002161 CH), Tatwah Smartech (002512 CH)
The Internet of things (物联网) Cloud computing (云计算)		China Digital TV (STV US), Tianyuan DIC info (300047 CH), Sumavesion Technologies (300079 CH), UFIDA Software (600588 CH), Kingdee (268 HK), Fujian Rongji Software (002474 CH), Chinasoft Intl (354 HK), Kingsoft (3888 HK), Taiji Computer (002368 CH), Qiming Info Tech (002232 CH) Shandong Langc (600756 CH)
High-end software (高端软件)		
High-end server (高端服务器) Virtual digital technology (数字虚拟)		Tianma Microelectronics (000050 CH), Ningbo GQY Video & Telecom (300076 CH), GoerTek (002241 CH), Shenzhen Laibao High-tech (002106 CH), Guangdong Goworld (000823 CH), Huayi Brothers (300027 CH), Alpha Animation (002292 CH)
New display technology (新型显示)		
IPV4 core equipment (下一代互联网核心设备)		Beijing Teamsun Tech (600410 CH),ZTE (763 HK), Digital China (861 HK)

Source: BofA Merrill Lynch Global Research

Three network integration

… the three network integration …

The idea to merge the three networks, i.e. telecom, internet and cable, was first discussed as early as in 1998. The idea makes a lot of sense economically: operators can share resources and consumers can benefit from increased competition – media companies (including cable operators) under State Administration of Radio Film and Television (SARFT) can provide internet and IP phone services while telcos under Ministry of Industry and Information Technology (MIIT) can conduct IPTV and mobile TV businesses.

Progress is speeding up

China has made little progress up until now with the integration due to turf fights between different interest groups. However, the government seems determined to jump start the initiative recently. In Jan 2010, the State Council laid out a rough timeline (Consolidation of the three networks?, 14 Jan 2010): 1) 2010-2012, to build up a regulatory framework & telcos and Cablecos to open their market to each other on a pilot test basis; 2) 2013-2015, to push forward with a full consolidation. On Jul 1, 2010, the State Council announced a pilot test program with Beijing, Shanghai, Harbin, Wuhan, Hangzhou, Nanjing, Shenzhen, Qingdao, Xiamen, and Dalian included as among the first batch of pilot test cities for the integration. On July 27, 2010, Shenzhen unveiled its plans, the first city to do so (Three-network integration, 30 Jul 2010).

Likely impact

We believe a merged network will increase competition in the telecom sector. This is negative to existing telecoms operators in our opinion. Although telcos will be allowed to enter IPTV and mobile TV, the additional revenue potential appears too small to compensate for the potential losses in their core business. On the other hand, telecom value added service (VAS) providers and media companies will likely benefit from reduced running costs, bigger customer base and value premium due to potential take-over opportunities.

Cable operators will most likely be net beneficiaries as they will be allowed to enter into the more lucrative telecom business after some upgrade to their existing networks. The industry also needs to consolidate first before it can compete with the big national telcos. Right now, most of the cable operators are controlled by their respective local governments.

Equipment vendors will be the most immediate beneficiaries because the integration requires network upgrades on both sides. Key investment areas include bandwidth, set top box (STB), software and content.

Listed companies with exposure to the integration

They include cable operators such as Gehua CATV (600037 CH), Shenzhen Topway Video (002238 CH); software developers such as Tianyuan DIC info (300047 CH); system integrators such as Sumavesion Technologies (300079 CH), China Digital TV (STV US); equipment makers such as Shenzhen Coship Electronics (002052 CH), Chengdu Geeya Technology (300028 CH); and VAS service providers such as Leshi Internet Info (300104 CH), CMMB Vision (471 HK) and DVN (500 HK). Major telecom equipment makers such as ZTE (763 HK) and system integrator such as Digital China (861 HK) may also benefit. For more details on these companies, please see Table 2.2.

The Internet of things

… the Internet of things …

The Internet of things refers to the interconnection of everyday objects via the Internet, including appliances, cars, industrial machines and traffic lights, to enable a more intelligent living. It's easy for us to imagine that it's widely adopted in areas such as smart power grid, smart traffic system, smart logistics system, smart home appliances, public security (i.e. monitoring), healthcare, defense, and etc. The new Internet Protocol Version 6 (IPv6), with its extremely large address book, will enable the net to communicate with virtually all human-made objects.

Problems & opportunities

China has a world class telecommunication and internet infrastructure but it's relatively weak in applications. Before the Internet of things can take off in China, it has to develop nationwide standards and cross industry technology expertise, and to encourage close co-operations among equipment vendors, system integration providers and operators.

The industry can be separated into 3 layers: censoring (identifying, positioning, tracking, and monitoring), information transmission, and application (software and service providers). Investment opportunities mainly come from censoring and application as transmission will unlikely become a significant business for the existing telecom operators anytime soon. The censoring industry seems to be the immediate beneficiary, particularly RFID (Radio Frequency Identification Device).

Given national security concerns, we suspect most of the equipment vendors will be domestic firms.

Listed companies with exposure to the Internet of things

Two companies we find in the market, Shenzhen Invengo Info (002161 CH) and Tatwah Smartech (002512 CH), make FRID products. For more details on them, please refer to Table 2.2.

New display technology

… new display technology such as 3D …

The State Council announcement doesn't specify what kind of display technologies it refers to but we suspect it probably means touch screen and 3D display (vs. traditional LCD).

3D display and listed exposure

3D TV's market potential looks huge. 3D movies (e.g. Avatar) are bringing 3D concept closer to the consumers. Many domestic and foreign brands are getting excited about 3D TV potential with some even believing that 3D will replace LCD soon. For example, Mr. Mu Gang, VP of Konka group, expected 3D to represent as much as 50% of his company's sales by 2011.

Key challenges are high prices and lack of content, with the latter being the bigger issue. Some TV makers are even considering producing 3D content by themselves.

Listed exposures are so far largely device makers such as Tianma Microelectronics (000050 CH), Ningbo GQY Video & Telecom (300076 CH) and GoerTek (002241 CH). For more details on them, please refer to Table 2.2.

Touch screen & listed exposure

Touch screen is widely used in mobile devices, including I-phone, I-pad and most smart phones. Potential exposures here are Shenzhen Laibao High-tech (002106 CH) and Guangdong Goworld (000823). For more details, please refer to Table 2.2.

Virtual digital technology

… virtual digital technology …

Virtual digital covers many areas, including digital mapping we will mention in the satellite section. The State Council announcement seems to emphasis on virtual movies and cartons, as it explicitly states to "promote the development of cultural and creative industries".

Unfortunately, we couldn't find any listed play at this stage although some movie and cartoon makers may ultimately benefit, e.g. Huayi Brothers (300027 CH) and Alpha Animation (002292 CH). For more details, please refer to Table 2.2.

Cloud computing

… cloud computing …

Cloud computing is a concept similar to the water or electricity system, i.e. computing power on demand. It sets up shared servers connected to the Internet that can provide storage, software and data to computer users. As a result, PC itself can be very simple - "Probably 640k memory is good enough for your terminal", according to Bill Gates. Privacy and data safety are the primary concerns for cloud computing.

Cloud computing is still at a concept stage in China and there is little direct exposure. UFIDA Software (600588 CH) has expressed strong interest on this. For company details, please refer to Table 2.2.

… and high-end software.

High-end software

Chinese software companies are generally weak by international standard. Due to reasons including security concerns, the government is trying to develop a strong local industry.

Most of the software makers have the high-tech status so are entitled to corporate tax concessions. Homegrown software companies also enjoy an effective VAT rate at 3% vs. a standard rate of 17%. More tax benefits may be on the way as the government is reviewing its current tax policies.

For security reasons and as a support to the local software industry, the government, as well as some SOEs, is using home grown software whenever it can. In fact, government purchase is the most important revenue source for many domestic software companies.

There are many listed domestic software makers and they include UFIDA Software (600588), Kingdee (268 HK), Taiji Computer (002368 CH), Beijing Teamsun Tech (600410 CH), Qiming Info Tech (002232 CH), Fujian Rongji Software (002474 CH), Chinasoft Intl (354 HK) and Kingsoft (3888 HK). More details are contained in Table 2.2.

Listed exposures to new generation IT

Table 2.2 provides more details on the companies mentioned in this section of the report.

Table 2.2: Exposures to new generation IT

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
STV US	China Digital TV	0.4	Digital TV software	High	Provides conditional access (CA) systems to the digital television market. The Company also licenses set-top box designs to set-top box manufacturers and sells digital television application software such as electronic program guides and subscriber management systems to digital television network operators.
471 HK	CMMB Vision	0.0	Mobile TV	High	Mobile television and interactive multimedia.
500 HK	DVN	0.1	VOD	High	Develops digital cable TV platform services and provides Internet based Video-on-demand (VOD) services
300104 CH	Leshi Internet Info	1.0	Video	High	Video website. The company has internet video and mobile phone video licenses, and has help China Unicom to build a pilot test platform. The platform could carry video calls, pc/tv/iphone/ipad switch, using mobile phone as a remote controller, video sharing among mobile phone / TV / PC.
300047 CH	Tianyuan DIC info	0.5	Telecom software	High	Telecom and public security industry software. Key products include real-time online billing software, quasi real-time billing software, and customer relationship software for the telecommunications industry.
600037 CH	Gehua CATV	2.0	CATV	High	Beijing based CATV company, a pilot test company for three network integration.
002238 CH	Shenzhen Topway Video	1.1	CATV	High	Shenzhen based CATV company. Currently the company is integrating the cable TV networks in Shenzhen, and potentially in Guangdong province.
002052 CH	Shenzhen Coship Electronics	0.5	Set top boxes	High	Key products include digital satellite receivers, digital cable receivers, digital terrestrial receivers, digital displays, and IPTV products.
300079 CH	Sumavesion Technologies	1.2	Digital TV software	High	Developers digital TV software and hardware products. Key products are digital TV conditional access system and digital TV front-end equipment etc.
300028 CH	Chengdu Geeya Technology	0.4	Digital TV equipment	High	Specialized digital television equipment. Key products include DTV head-end series equipment, CAS, and SMS system software.
002161 CH	Shenzhen Invengo Info	1.4	RFID products	High	Provides UHF RFIDproducts, including tag, reader, antenna and spin off products to customers in railway transportation, intelligent traffic, manufacturing, logistics, retail, consumer goods, pharmaceuticals and other industries.
002512 CH	Tatwah Smartech	0.6	RFID products	High	Various types of radio-frequency identification (RFID) products. Its main product is label card, such as non-contact IC cards and electronic labels.
000050 CH	Tianma Microelectronics	1.3	3D display	Low	A LCD maker (small size). The company also produces materials for 3D glasses; Goertek is its biggest client.
300076 CH	Ningbo GQY Video & Telecom	0.4	3D display	Low	Key products are large screen display system and digital laboratory apparatus. The company made some breakthrough in 3G technology.
002241 CH	GoerTek	3.1	3D display	Low	Bluetooth wireless devises, active noise cancellation headphones, VoIP devices, hands-free headsets, and other electro-acoustic devices. The company also produces 3D glasses (for 3D TV) for Samsung.
002106 CH	Shenzhen Laibao High-tech	4.3	Touch screen	High	The company is quickly expanding its touch screen manufacturing capacity. It can produce both small size and mid-large size touch screens.
000823 CH	Guangdong Goworld	1.1	Touch screen	Low	Manufactures PCB, LCDs, and ultrasonic electronic measuring instruments. The company manufactures touch screen through its subsidiary, current expanding capacity.
300027 CH	Huayi Brothers	1.5	Movie	Low	The only listed movie maker in China
002292 CH	Alpha Animation	1.4	Animated toys	Low	Main business is animated toys, animated TV, movies and books. Its businesses model is to use animated TV/movies to promote the sales of its animated toys.
600588 CH	UFIDA Software	2.9	ERP, cloud computing	High	A leading Chinese ERP software vendor. Key software products include financial, web-based, management, and security development software. The company has an ambition in cloud computing.
268 HK	Kingdee	1.2	ERP	High	Develops enterprise management software, e-commerce application software and middleware software.
002368 CH	Taiji Computer	0.8	IT consulting	High	IT consulting, competing with IBM.
600410 CH	Beijing Teamsun Tech	1.4	System integration	High	Provides system integration service to the telecom and finance industry. The Company also provides consulting services.
002232 CH	Qiming Info Tech	1.0	Auto information system	High	Auto information system is a key growth driver. Its new products have mobile TV functions. Price range RMB5000-8000/set. Main partners are FAW Volkswagen and Shanghai Volkswagen. Currently, the products didn't get authorization to be pre-installed on Volkswagen cars yet. But it has signed strategic agreement with Volkswagen China to realize quasi pre-installation, i.e. install the products in Volkswagen 4S stores before the cars are sold.
002474 CH	Fujian Rongji Software	0.8	Software	High	Develops software for the government (e-government), defense departments, quality control departments, the energy industry, and the telecoms industry.
354 HK	Chinasoft Intl	0.3	Software	High	Provides solutions to government authorities and its IT service providers
3888 HK	Kingsoft	0.6	Software	High	Role-playing computer games and security, translation, and spreadsheet software.

Source: BofA Merrill Lynch Global Research

Bio-technology

For biotechnology, the State Council's announcement highlighted a few key development areas: bio-medicine, new generation vaccines and diagnostic reagents, chemical medicine and modern TCM (traditional Chinese medicine) to prevent and treat major diseases; advanced medical equipment and materials; bio-seeding; marine biology (Table 3.1).

Table 3.1: Bio-technology sector overview

Targeted areas	Policies	Relevant stocks
Bio-medicines, chemical medicines, TCM, diagnostic reagents and new vaccines for major disease prevention & control (重大疾病防治的生物技术药物、新型疫苗和诊断试剂、化学药物、现代中药)	To raise industry standards; To push for industry consolidation; More tax (VAT, business tax, corporate income tax) cut and loan support to companies' capex, R&D spending; More funding to support domestic brand-name drugs and high-tech generic drugs.	Cancer treatment drugs: Jiangsu Hengrui (600276 CH), Livzon Pharmaceutical (000513 CH) Cardiology drugs & TCM: Harbin Pharmaceutical (600664 CH), Beijing Double Crane (600062 CH), Tianjin Lisheng (002393 CH), Jinling Pharmaceutical (000919 CH), Tianjin Tasly (600535 CH), Tianjin Zhong Xin (600329 CH), New vaccines - Type I: Beijing Tiantan (600161 CH) New Vaccines - Type II: Walvax (300142 CH), Chongqing Zhifei (300122 CH), Beijing Tiantan (600161 CH), Hualan (002007 CH), Liaoning Cheng Da (600739 CH) Diagnosis reagent: Da An Gene (002030 CH), Shanghai Kehua (002022 CH), Shanghai Fosun (600196 CH), Zhejiang Hisun (600267 CH)
Advanced medical equipment and materials (先进医疗设备、医用材料)		Mindray (MR US), Shanghai Kehua (002022 CH), CMED (CMED US)
Bio breeding, green agriculture (生物育种、绿色农用生物产品)		Shandong Denghai (002041 CH), Hefei Fengle (000713 CH), Yuan Longping High-Tech (000998 CH)
Key technologies in bio-production (生物制造关键技术)		Feed: Tongwei (600438 CH), Guangdong Haid (002311 CH)
Marine biology (海洋生物)		Breeding: Dalian Zhangzidao (002069 CH), Dalian Yi Qiao Marine (002447 CH), Shandong Oriental Ocean (002086 CH), Shandong Homey Aquatic(600467 CH) Mariculture: Dalian Zhangzidao (002069 CH), Shandong Oriental Ocean (002086 CH), Shandong Homey Aquatic(600467 CH)

Source: BofA Merrill Lynch Global Research

Healthcare market big & getting bigger

The size of the healthcare market in China is big and growing fast.

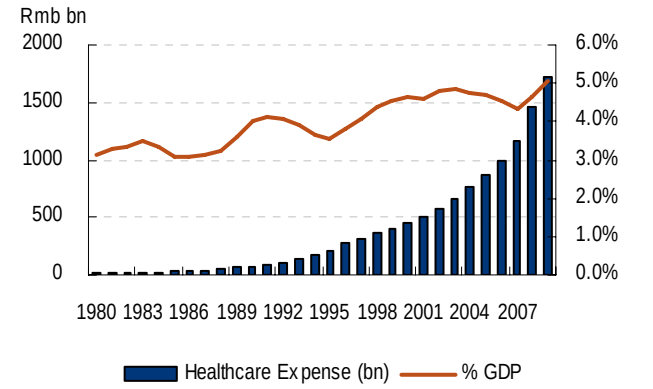
China's health spending skyrocketed over the past 20 years, and reached Rmb1.7tr in 2009, representing 5.1% of GDP vs. 4.8% in 2008 (Chart 3.1). Out of this, 27% came from the government, vs. 25% in 2008 (Chart 3.2). We expect the trend to continue as more spending on public services, including on healthcare, features prominently in the current round of the Chinese government's structural reform program ("The visible hand – A reform roadmap & what it means", 23 Jul 2010). An aging population also supports healthcare spending (Sadiq Currimbhoy, "Youth Shall Set You Free", 28 Jun 2010). China ranked as the seventh largest pharmaceutical market in 2009 and is on track to become the second largest market by 2020 based on IMS Health's projections (Table 3.2).

Table 3.2: Pharmaceutical market size ranking 2001-2020

2001		2005		2009		2020 (E)	
Country	Ranking	Country	Ranking	Country	Ranking	Country	Ranking
USA	1	USA	1	USA	1	USA	1
Japan	2	Japan	2	Japan	2	China	2
German	3	German	3	German	3	Japan	3
France	4	France	4	France	4		
Italy	5	Italy	5	UK	5		
UK	6	UK	6	Italy	6		
Spain	7	Spain	7	China	7		
Canada	8	Canada	8	Spain	8		
Mexico	9	China	9	Canda	9		
China	10	Mexico	10	Turkey	10		

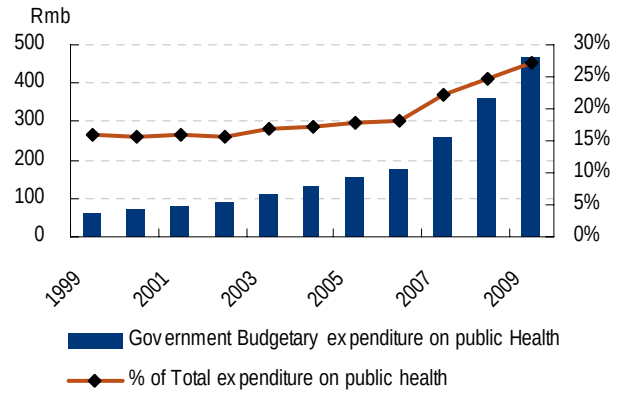
Source: IMS Health, BofA Merrill Lynch Global Research

Chart 3.1: Healthcare expense as % of GDP – 1980-2007



Source: CEIC, BofA Merrill Lynch Global Research

Chart 3.2: Government budgetary expenditure vs. total expenditure on healthcare



Source: CEIC, BofA Merrill Lynch Global Research

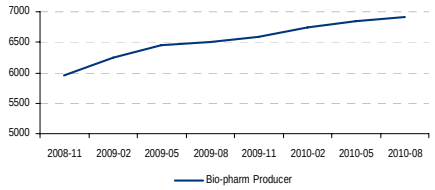
However, Chinese biopharmaceutical companies are weak.

Biopharmaceutical companies weak

While demand outlook looks strong, domestic biopharmaceutical companies are weak.

Despite the fact that the domestic industry only really emerged over the past ten years or so, there are close to 7,000 bio-pharmaceutical companies in China by now (Chart 3.3). Unfortunately, most of them are small and focus on low-end medicines. They either can not afford to spend on R&D or are reluctant to invest, choosing instead to focus on low cost generic drugs and compete on prices, sometimes resorting to bribes (Shaojing Tong/Binnie Wong, "Remain cautious as headwinds continue", 05 Jul 2010). According to Science Technology Daily, the official newspaper of the Ministry of Science and Technology (MOST), only half of the large drug makers in China have an in-house R&D team. Most research is conducted by government sponsored research institutes and universities which pay little attention to market demand (although the government is trying to change this now). There are also very little coordination, resulting in duplicated efforts, waste and in some cases, excessive capacity.

Chart 3.3: Bio-pharmaceutical producer number



Source: SIC, BofA Merrill Lynch Global Research

Government policy focus

The government wants to improve affordability and foster innovation and domestic brands.

In our opinion, there are two main agendas for the government for the pharmaceutical industry: 1) to improve affordability, quality and effectiveness of drugs for the mass; 2) to foster a domestic pharmaceutical industry that can innovate, develop its own drugs and brands, including, but certainly not limited to, traditional Chinese medicine (TCM) drugs. Sometimes, these two goals are conflicting so the government needs to achieve a balance. Overall, the second goal, which this report largely focuses on, is arguably more important because over time it will lead, hopefully, to better and more affordable drugs. Table 3.3 shows major policy announcements for the pharmaceutical industry in recent years.

Table 3.3: Government policies 2005-2010

Jun-05	Guideline on distribution and application of vaccine; Distribution of Type II vaccines * deregulated.
Mar-06	Guideline on storage and shipment of vaccines; Industry standards tightened.
Jun-06	Guideline for vaccine quality control.
2007	SFDA tightened the approval of new generic drugs to encourage the development of brand-name drugs.
Apr-07	Vaccine development included in the industry's 11th Five-Year Plan.
May-07	A guideline to tighten control over vaccine distribution.
Jul-07	SPDA issued a new guideline on drug approval to encourage brand name drugs.
Dec-07	The State Council announced that it will launch a national program to support the R&D of critical new medicines, targeting five projects that focused on innovative methods to diagnose and cure tumor, cardiovascular, diabetes related diseases.
Feb-08	MOH increased the number of diseases that require vaccines from 6 to 14.
Jun-09	The State Council issued policies to support development of biology related sectors, including 150% of R&D expenses from corporate income tax deduction, more government purchase of biological products, and more support to the industry's financing needs (better access to bank loans, IPOs etc.)
Jul-09	MOH called for focused efforts on major diseases, and pushed for more application of Type I# vaccines.
Aug-09	China added TCM onto the Essential Drug List (EDL).
Jan-10	China government's first directive in 2010 called for more consolidation in the breeding sector and more cooperation among breeding institutes and seed producers.
Apr-10	SFDA released a notice to improve the safety of TCM injections. Measures include 1) to suspend businesses with backward technology, poor quality control, or bad quality track record; 2) to raise the entry barrier.
Nov-10	MOH and SFDA jointly published a guidance to speed up the structural reforms of pharmaceutical industry with an aim to develop 10+ brand-name medicines and 20+ generic drugs that are competitive globally; At least 15+ new biomedical drugs should be ready for market
Nov-10	NDRC cancelled preferential pricing for foreign brand drugs

Source: various news flows, BofA Merrill Lynch Global Research

* Type II vaccines - paid by individuals; more for adults, such as those for flu, rabies and HPV; they accounted for roughly 20% of approved vaccine types in 2009.

Type I vaccines - sponsored by the state, e.g. those used in nationwide kids' immunization of polio and measles.

Drugs for major diseases

One major area is drugs for major diseases, including …

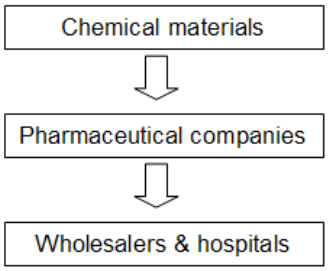
The State Council announcement does not define “major diseases”. There are two definitions issued by Ministry of Health (MOH) - one in 2007 at China Insurance Regulatory Commission (CIRC)’s request for insurance coverage; and the other in Sept 2010 for nationwide disease prevention and treatment. We will base on our analysis on the latter and the major diseases are AIDS, tuberculosis, schistosomiasis, malaria, echinococcosis, leprosy, endemic, hand, foot and mouth disease, epidemic hemorrhagic fever, brucellosis, dengue fever, rabies, cancer, chronicle disease, epilepsy, major mental illness and children's oral disease. Our discussion will focus on cancer, cardiology disease, and epidemics because of their market size. The related sectors are cancer drug, cardiology drug & TCM, diagnostic reagent and vaccine for epidemic. Please note the following discussions cover both chemical and biopharmaceutical drugs.

... cancer drugs ...

Cancer drugs

The market is characterized by high entry barrier (complicated technologies), high growth (more people can afford treatment as income rises and government's healthcare coverage expands), high margin (gross margin at around 80% for many drug makers), a growing share of domestic players (6 out of the top 10 cancer drug makers by now), and emerging industry consolidation (the top 10 makers accounted for 43% of total market share in 2007).

Chart 3.4: Value chain – cancer treatment drugs



Source: BofA Merrill Lynch Global Research

The value chain for cancer drugs is shown in Chart 3.4. Along the chain, drug makers and hospitals have better bargaining power than raw material suppliers, drug production equipment makers or wholesalers. Foreign manufacturers dominate the high-end market, as the market recognizes them as providers of new and high-quality drugs. Local players dominate generic drug market due to their cost advantage. A list of listed players is contained in Table 3.4.

Table 3.4: Exposures to cancer treatment drugs

Company	Ticker	Market cap (USD bn)	Market share
Jiangsu Hengrui Medicine C-A	600276 CH	6.6	7%
Jilu Medicine	Not listed	NA	4%
Guizhou Baiqiang	Not listed	NA	2%
Nanjin Sike	Not listed	NA	2%
Livzon Pharmaceutical	000513 CH	1.5	2%
Hainan Zhonghe	Not listed	NA	2%
Jiangsu Hansoh	Not listed	NA	2%
Lanle	Not listed	NA	2%
Zhejiang Hisun	Not listed	NA	2%

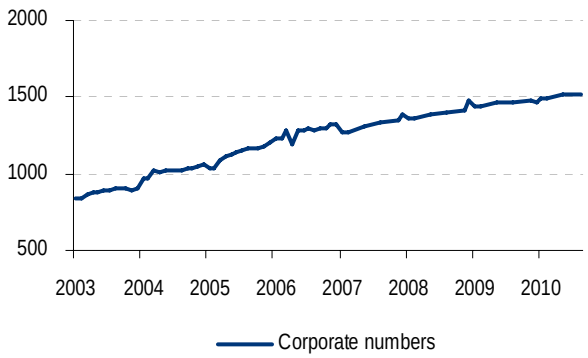
Source: BofA Merrill Lynch Global Research

... cardiology drugs where TCM is strong ...

Cardiology drugs

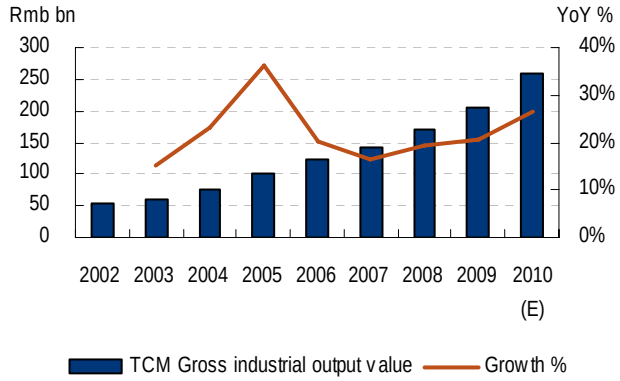
This market is characterized by high growth (20% sales CAGR since 2002), high margin (40%+ gross margin for many players) and rising influence of TCM. The number of TCM drug makers rose from 840 in 2003 to 1,464 in 2009 (Chart 3.5 and 3.6). Unlike in other pharmaceutical segments where its markets tend to be small, TCM has about half of the cardiology drug market because of proven effects and a common perception among the locals that TCM outperforms western medicines in treating chronological diseases. While a few global players dominate the western medicine market in this area, the cardiology drug TCM market consists of numerous players. For example, there are 687 makers for just one type of popular product (复方丹参片).

Chart 3.5: No. of TCM makers



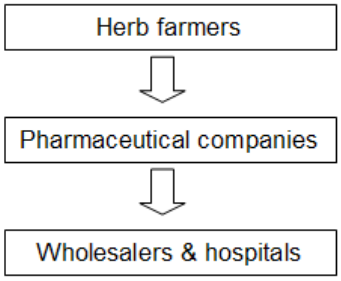
Source: CEIC, BofA Merrill Lynch Global Research

Chart 3.6: TCM gross industrial output value



Source: CEIC, SFDA, BofA Merrill Lynch Global Research

Chart 3.7: Value chain – TCM



Source: BofA Merrill Lynch Global Research

There are two value chains for cardiology drugs - the one for western medicines is very similar to that of cancer drugs (Chart 3.4), and the one for TCM is shown in Chart 3.7. Supply of herbs, raw materials used to make TCM, is often problematic. As farmers generally do not know market conditions very well, some times others can come in and manipulate the market. For example, in 2009-2010, speculators hoarded large quantity of sanqi and pushed it price to 8X of historical average (A case study of Sanqi price, Dec 2, 2010). As drug prices are often regulated by the government, TCM makers' margins sometimes can get squeezed. A list of listed Chinese cardiology drug makers is in Table 3.5.

Table 3.5: Exposures to cardiology & TCM drugs

Company	Ticker	Market cap (USD bn)	Market share	Product type
Harbin Pharmaceutical	600664 CH	4.4	NA	Western medicine
Beijing Double Crane	600062 CH	2.6	5%	Western medicine
Buchang Group	Not listed	NA	N/A	TCM
DiAo	Not listed	NA	N/A	TCM
Tianjin Lisheng	002393 CH	1.4	1%	Western medicine
Jinling Pharmaceutical	000919 CH	0.9	NA	TCM
Tianjin Tasly	600535 CH	3.1	NA	TCM
Tianjin Zhong Xin	600329 CH	1.5	NA	Western medicine

Source: BofA Merrill Lynch Global Research

... vaccines ...

Vaccines

Both type I (paid by the government) and type II (paid by private individuals) markets are characterized by high entry barrier (regulatory), capital intensity, and strong bargain powers by distributors/customers. The entry barrier is high as a player needs to obtain multiple certifications for production and sales. Capital investment is substantial as both production and distribution demand hygiene and temperature control. Distributors and customers prefer suppliers with proven track record due to concerns of potential public health incidents.

Type I market, funded by the government and competitively priced, is dominated by domestic companies with low margin but stable volume growth. Foreign companies often find this market unattractive.

Type II market generally enjoys high price and high margin initially but price and margin normally decline rapidly when peers catch up with similar products. It involves lengthy R&D and has more participation by foreign players. The market is growing fast, driven by rising public awareness of the benefits of immunization and improving affordability. But sales volume can fluctuate substantially year to year because of the random nature of epidemics. For example, when H1N1 broke out in 2009, demand from the government and the public both exploded, but it soon declined after the crisis was past.

The production of biological media and chemical reagent has been commoditized. China Biological Tech Group, an SOE, dominates the research, production and sales of type I vaccines in China. Tiantan is its listed subsidiary (Table 3.6)

Table 3.6: Exposures to type I vaccine

Company	Ticker	Market cap (USD bn)	Market share
Beijing Tiantan	600161 CH	1.8	83%

Source: BofA Merrill Lynch Global Research

Type II vaccine market is much more fragmented – SOEs have about 35% of the market, private companies about 50%, and foreign companies, the remaining 15%. Market competition is heated and successful wholesalers have strong bargain powers.

Table 3.7: Exposures to type II vaccines

Company	Ticker	Market cap (USD bn)	Market share
Zhejiang Tianyuan	Not listed	NA	NA
Walvax	300142 CH	2.1	NA
Chongqing Zhifei	300122 CH	2.4	NA
Beijing Tiantan	600161 CH	1.8	NA
Hualan	002007 CH	4.3	NA
Liaoning Cheng Da	600739 CH	4.5	NA

Source: BofA Merrill Lynch Global Research

Diagnostic reagent

… and diagnostic reagent.

The diagnostic reagent market is characterized by high growth, heated competition, low margin and dominance in the high-end by foreign companies. Sales have been growth at 15-20% p.a. in recent years. Price war was heated in the 1990s and even now, for each reagent type, there are roughly some 80 domestic producers on average. Gross margin is around 10-20%, much lower than those in many other pharmaceutical segments. Margin in the high end market is considerably higher because foreign companies usually charge prices that are 2-5X higher than domestic products'. Domestic producers have been trying to break into the high end, but so far have not succeeded in general. One of the main reasons is that most reagents need to be used with compatible equipment, the market of which is dominated by foreign players (market share >50%).

A new opportunity may emerge from the current round of healthcare reform. As the reform caps medicine mark-up at 15% to improve drug affordability for patients, hospitals need to find alternative incomes. So far, diagnosis charge is not on the government's control list.

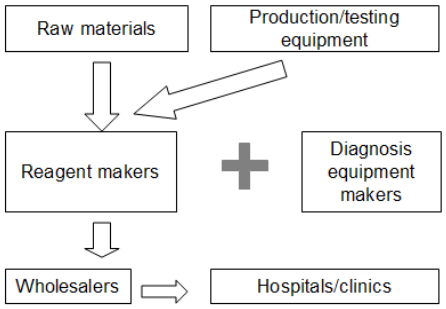
Growth potential in the industry is substantially. In 2009, diagnosis expenses only accounted for less than 10% of total healthcare spending in China, vs. 20-30% in the developed countries. The industry expects a few changes: 1) more immune diagnostic reagents, less clinical biochemistry reagents. 2) more diagnosis via highly integrated instruments, and faster ones; 3) more varieties of reagents; 4) less research time to develop reagents, shortened by modern biological techniques such as genetic engineering, gene recombinant and monoclonal antibodies.

Table 3.8: Market dynamics

	% of total market	Market dynamics
Clinical and biochemical diagnosis	30%	The high-end dominated by foreign players (equipment compatibility); heated competition in the low-end among domestic players.
Immune diagnosis	25%	Low entry barrier, high growth, high margin, heated competition.
Molecular diagnostics (PCR)	35%	High entry barrier from patents protection; high margin; a handful of domestic players; no foreign players.
Others	10%	Niche segments, dominated by foreign players

Source: BofA Merrill Lynch Global Research

Chart 3.8: Value chain – diagnosis reagent



Source: BofA Merrill Lynch Global Research

Chart 3.8 shows the value chain for the diagnosis reagents market. For clinical and biochemical diagnosis, raw materials and production/testing equipment are fairly commoditized, so the major competitive edge is the compatibility with diagnosis equipment (Table 3.10). The other three segments are still dominated by foreign companies in the supply of both raw materials and equipment. For example, 20-50% of Da An Gene's raw materials and equipment are imported.

KHB (002022 CH) is founded in 1998. It is the first and also the largest domestic player, focusing on clinical and biochemical diagnosis. In 2009, the government asked it to participate in the HIV virus detection research program. In 2010, its H1N1 virus reagent and related equipment are certified by SFDA.

Fosun Pharmaceutical (600196 CH) is another major domestic player in clinical and biochemical diagnosis. It focuses on hepatic disease, diabetes medicine, gynecological medicines and clinical diagnosis products.

Table 3.9 lists some players engaged in diagnosis business.

Table 3.9: Exposures to diagnosis reagents

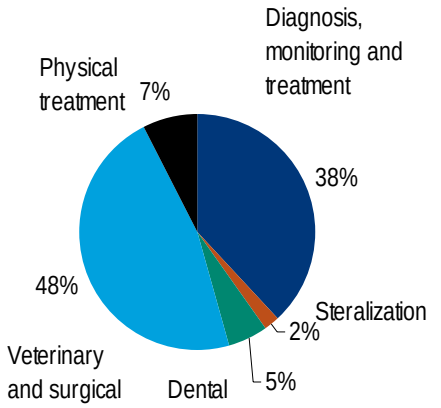
Company	Ticker	Market cap (USD bn)	Market share	Market segment
Da An Gene	002030 CH	0.7	NA	Molecular diagnostics (PCR)
Shanghai Kehua	002022 CH	1.4	NA	Clinical and biochemical diagnosis
Shanghai Fosun	600196 CH	4.0	NA	Clinical and biochemical diagnosis

Source: BofA Merrill Lynch Global Research

Medical devices

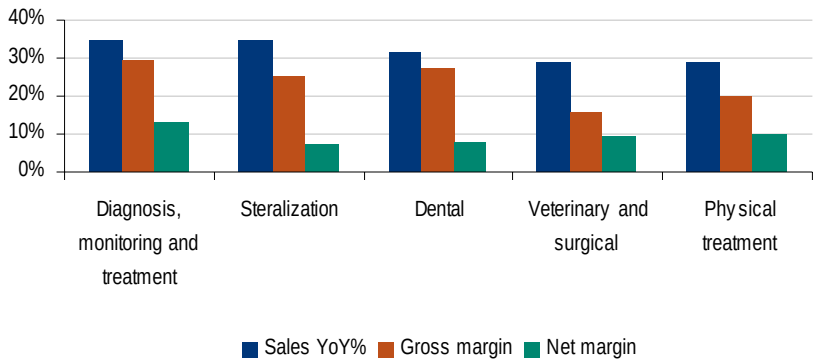
For medical device, the market consists of 5 segments (Chart 3.9): diagnosis, monitoring and treatment (DMT), sterilization, dental, veterinary and surgical and physical treatment. Among the five, DMT is the one where Chinese makers are the most behind vs. global peers and where the government probably will spend the most efforts to support. The DMT market is big (Rmb29bn in sales in 2009), more profitable and growing fast (Chart 3.10) – the current penetration is low and the roll out of hospitals in rural areas will also need more devices. For example, in 2009, every 100 ward beds in China were equipped with about 20 monitoring devices vs. 80 in US.

Chart 3.9: Market split - medical devices 2009



Source: NBS

Chart 3.10: Segment performance 2009



Source: NBS, BofA Merrill Lynch Global Research

Medical device is another important area for the healthcare industry.

Similar to other industries, low end market is commoditized and largely the play field of domestic device makers while the high end is controlled by foreign companies and enjoys better margins. Many hospitals and patients themselves prefer foreign devices for their proven quality. But domestic makers are gaining market share with low prices and better after sale services (labor cost is lower). Some domestic firms, such as Mindray and Kehua, are also moving up the value chain. Currently, most device makers sell directly to hospitals.

A list of Chinese device makers is in Table 3.10.

Table 3.10: Exposures to DMT medical devices

Company	Ticker	Market cap (USD bn)	Market share	Market segment
Mindray	MR US	3.0	NA	Diagnosis, monitoring and treatment
Shanghai Kehua	002022 CH	1.4	NA	Diagnosis, monitoring and treatment
CMED	CMED US	0.4	NA	Diagnosis, monitoring and treatment
Edan	Not listed	NA	NA	Diagnosis, monitoring and treatment
Goldway	Not listed	NA	NA	Diagnosis, monitoring and treatment
Biolight	Not listed	NA	NA	Diagnosis, monitoring and treatment

Source: BofA Merrill Lynch Global Research

Bio-seeding & green agriculture bio-products

To improve food safety and supply security, the government is targeting …

Bio seeding consists of bio-breeding and seed production. To ensure food quality and supply safety, the Chinese government has been a consistent supporter to the sector. Table 3.11 contains some of the recent supportive policies to green farming.

Table 3.11: Government policies - green farming

Jan-10	CPC's Rural Affairs Meeting stated that seeding is strategically important for China's agriculture sector
Jan-10	The State Council's first directive in 2010 called for industry consolidation in the seeding sector and more cooperation among breeding institutes and seed producers.
Aug-10	NDRC vowed to provide more support to help to increase grain supply, e.g. more support to bio-seeding sector, to develop large breeding companies with core competency; to provide fiscal subsidies and more tax benefits (current tax benefits: VAT exemption for domestic sales, corporate income tax rate at 15%).
Oct-10	The 5th Plenary of the 17th National People's Congress decided that China will spend significant efforts to develop the seeding sector.
Dec-10	State Council called to develop modern farming practice in North Eastern China

Source: various news flow, BofA Merrill Lynch Global Research

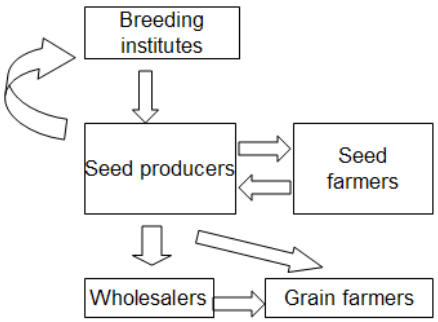
Breeding & seed production

… bio-seeding and breeding …

The breeding sector is fragmented in China. Each region used to manage its own breeding and seed distribution, and the practice was only abolished in 2000. The majority of Chinese breeders are SOE research institutes although private companies are becoming increasingly active. All top 10 global players have presence currently in China as well. Entry barrier is high because a breeder needs both a huge pool of candidate seeds and a strong R&D team to identify the promising ones. Margin and growth tend to be fairly stable, helped by the government's strong support to the sector.

Seed production on the other hand has a low entry barrier. In 2009, China had some 8,700 producers, and according to Ministry of Agriculture (MOA), 70% of them are very small. Most seed producers, because they are land constrained, outsource seed growing to private farmers. Competition in the sector is intense.

Chart 3.11: Value chain – bio breeding



Source: BofA Merrill Lynch Global Research

The value chain of bio-seeding is shown in Chart 3.11. Many breeding institutes are seed producers as well. Table 3.12 lists some of the key players.

Table 3.12: Exposures to bio breeding

Company	Ticker	Market cap (USD bn)	Market share	Market segment
Shandong Denghai	002041 CH	1.7	NA	Breeding & seed production
Hefei Fengle	000713 CH	0.7	NA	Breeding & seed production
Yuan Longping High-Tech	000998 CH	1.2	NA	Breeding & seed production
Tunyu Seed	Not listed	NA	NA	Breeding & seed production
China Seeds	Not listed	NA	NA	Breeding & seed production
China Institute of Agricultural Science and Technology	Not listed	NA	NA	Breeding
Seed development subsidiary of China Agricultural University	Not listed	NA	NA	Breeding
Gansu Dunhuang Seed	600354 CH	1.0	NA	Seed production
China Institute of Agricultural Science and Technology	Not listed	NA	NA	Breeding
Seed development subsidiary of China Agricultural University	Not listed	NA	NA	Breeding

Source: BofA Merrill Lynch Global Research

… bio-fertilizer and bio-pesticide …

Bio-fertilizer & bio-pesticide

The market is characterized by high growth, low entry barrier and low market concentration. By 2008, bio-fertilizer accounted for 18% of China's total fertilizer output. There were 500+ bio-fertilizer makers in 2007, according to MOA. Most makers focus on production, and leave the R&D to state sponsored research institutes. As a result, they tend to have similar microbiology and the end products can hardly differentiate. We are not aware of any listco in this sector.

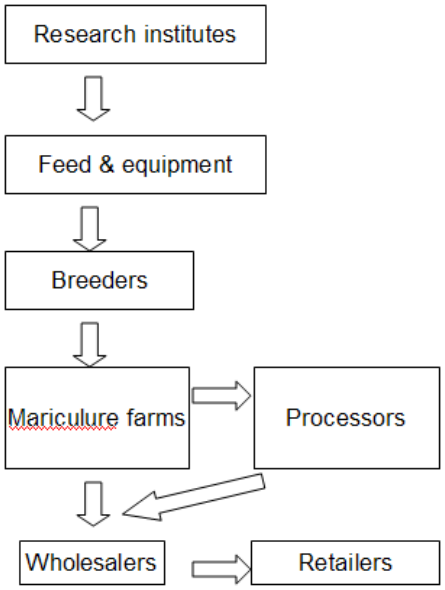
Bio-pesticide includes microbiology and agriculture-used antibiotics. So far, most Chinese makers are involved in the latter. Similar to the regular antibiotics industry, bio-pesticide industry has low entry barrier, faces heated competition and makes low margin (around 10% in operating margin). The market is relatively small, about 3-5% of overall pesticide sales. Table 3.13 contains a list of bio-pesticide makers.

Table 3.13: Exposures to bio-pesticide

Company	Ticker	Market cap (USD bn)	Market share
Shandong Lukang	600789 CH	0.8	NA
Zhejiang Qianjiang	600796 CH	0.3	NA
Zhejiang Shenghua	600226 CH	0.7	NA
Hebei Weiyuan	600803 CH	0.5	NA

Source: BofA Merrill Lynch Global Research

Chart 3.12: Value chain – marine biology



Source: BofA Merrill Lynch Global Research

... and marine biology.

Marine biology

This sector includes breeding & mariculture research, feed & equipment producing, breeding, mariculture, and distribution. The value chain is shown in Chart 3.12. Table 3.14 contains a list of recent policies for the sector. Overall, the government considers mariculture an important source of income for fishing farmers and an increasingly important supply source of food as Chinese upgrade their diet.

Table 3.14: Government policies - marine biology

May-03	The State Council issued a 10-yr (2001-2010) framework for marine-based economy to encouraged private investment in mariculture and called for local governments" support
Jan-05	China raised entry barrier for marine breeding
Dec-07	NDRC issued the 11th Five Year plan for fishery with a target of 70%+ contribution from mariculture to total aqua product output by 2010
Jan-09	SAT exempted VAT for aqua product domestic sales
Jan-09	SAT lowered corporate income tax rate by half (now at 12.5%) for entities or individuals engaged in fishery

Source: BofA Merrill Lynch Global Research

The regulatory entry barrier is low and so far the government hasn't really pushed for industry consolidation. R&D is mainly conducted by research institutes and few listed players are involved. We focus on the rest of the value chain in this section. In general, Chinese players dominate the feed, breeding and mariculture market given their local knowledge and access to local marine resources.

Feed

The feed market appears unattractive with a heavy reliance on imported materials, low entry barrier, heated competition and low margin. Fish meal, a key raw material, is usually imported from Peru and other South American countries, and accounts for 30-50% of production cost. The entry barrier is low and China has roughly 700-800 marine feed makers. Out of them, only 25 have an annual capacity that's greater than 30K tons. Industry margin has dropped significantly over the years and recently gross margin is around 20-25% at the upper range. Industry consolidation has started recently, both between feed makers and with breeders. One catalyst is fish & shell food safety incidents in China, as more mariculture farms are now willing to pay for stable quality which large makers can offer. Table 3.15 lists some feed makers.

Table 3.15: Exposures to feed makers for mariculture

Company	Ticker	Market cap (USD bn)	Market share
Tongwei	600438 CH	1.0	NA
Evergreen	Not listed	NA	NA
Guangdong Haid	002311 CH	1.5	NA
Chaitai	Not listed	NA	NA

Source: BofA Merrill Lynch Global Research

Breeding

The breeding market also has a low entry barrier. By 2009, there were 5,000+ breeders in China, and most of them were family owned. They tend to focus on the breeding of a few types of fish or shellfish, using outdated technology. As a result, many of them suffer from species degradation. Only a few large players work with research institutes on technology upgrade. Industry consolidation has started as customers need large scale supply with stable quality. As breeders need to maintain the temperature of breeding pools at a certain level throughout the winter, coal cost often contributes to 30-40% of their production cost. Table 3.16 contains some listed breeders in China.

Table 3.16: Exposures to breeders

Company	Ticker	Market cap (USD bn)	Market share
Dalian Zhangzidao Fishery -A	002069 CH	3.0	NA
Dalian Yi Qiao Marine Seed-A	002447 CH	0.8	NA
Shandong Oriental Ocean -A	002086 CH	0.7	NA
Shandong Homey Aquatic Dev-A	600467 CH	1.3	NA

Source: BofA Merrill Lynch Global Research

Mariculture farm

Similar to breeding, the sector is characterized by low entry barrier, heated competition and declining margin. In addition, it's more vulnerable to natural disasters. The sector has many small players concentrated in the low end, which drags down industry margin. Unlike breeding, mariculture farms are run in a much larger area, so they are more vulnerable to natural disasters, e.g. typhoons, sea pollution and unusually cold winter. Major players are entering into downstream distribution to seek better margin. A list of key players is in Table 3.17.

Table 3.17: Exposures to mariculture farm

Company	Ticker	Market cap (USD bn)	Market share
Dalian Zhangzidao Fishery -A	002069 CH	3.0	NA
Shandong Oriental Ocean -A	002086 CH	0.7	NA
Shandong Homey Aquatic Dev-A	600467 CH	1.3	NA
Xunshan Group	Not listed	NA	NA
Bangchuidao Group	Not listed	NA	NA

Source: BofA Merrill Lynch Global Research

Access to unpopulated water resources may become a more and more important differentiator for breeders and mariculture farms.

High-end Equipment

Five sectors in the high-end equipment manufacturing industry are singled out by the government as key development areas: they are aviation, satellite, track transportation, offshore, and intelligent manufacturing equipment (Table 4.1).

Table 4.1: High-end equipment sector overview

Targeted areas	Policies	Relevant stocks
Regional aircraft, large aircraft and general-purpose aircraft (干支线飞机和通用飞机)	Heavy government investment; Opening-up the sky for general aviation; Tax benefits and subsidies for manufacturers; Subsidies to end users.	Parts manufacturer: Xi'an Aircraft Intl (000768 CH), Xi'an Aero-engine (600893 CH), AVIC Aero-engine controls (000738 CH), China AVIC Avionics Equip (600372 CH), Hubei Aviation Precision (002013 CH) Aircraft manufacturing: AviChina (2357 HK), Hongdu Aviation (600316 CH), Harfei Aviation (600038 CH) Operation and MRO: Sichuan Haite High-tech (002023 CH)
Aerospace, satellite and their applications (空间基础设施，卫星及其应用产业)		Satellite equipment: China Dongfanhong Spacesa (600118 CH), China Aerospace Times Elec (600879 CH), Chengdu Goldtel Elec (300101 CH) Navigation: Beijing BDStar Navigation (002151 CH), Beijing Unistrong Science (002383 CH), Navinfo (002405 CH), Beijing Supermap Software (30003 CH)
Track-based transportation equipment, including those for passenger train and metros (客运专线和城市轨道交通等重点工程，轨道交通装备)		Rolling stock & parts: China South Locomotive (1766 HK), China CNR (601299 CH), Baotou Beifang Chuangye (600967 CH), Jinxi Axle (600495 CH), GEM-year (601002 CH), Zhuzhou Times New Materials (600458 CH), Zhuzhou CSR Times Electric (3898 HK)
Offshore equipment (海洋工程装备)		Offshore engineering and development design: Zhenhua (600320 CH), Shanghai Bestway Marine (300008 CH) General contractor of offshore oil and gas field development: Offshore Oil Engineering (600583 CH) Oil and gas exploration and production services: China Oilfield Services (2883 HK) Offshore drilling platform manufacturing: China CSSC (600150 CH), China Shipbuilding Industry (601989 CH)
Digital, flexible, integrated intelligent equipment (以数字化、柔性化及系统集成技术为核心的智能制造装备)		CNC tools: Kunming Mahchine Tool (300 HK), Shenyang Machine Tool (000410 CH), Qinchuan Machinery (000837 CH), Weihai Huadong Automation (002248 CH) Industrial robots: Siasun Robot & Automation (300024 CH)

Source: BofA Merrill Lynch Global Research

Aviation industry

Exhibit 4.1: General-purpose aviation

Source: NASA, BofA Merrill Lynch Global Research

Boeing estimates that China will take delivery of 4,330 new airplanes valued at US$480bn over the next 20 years. Booming demand in China provides the country with very strong incentives to make aircrafts of its own so as to develop its own market, reduce imports and perhaps to compete in the international market in the long term. China has been making regional airlines for years and is now developing its own wide-body aircrafts.

Regional airliners

Currently, Chinese made regional airliners are mainly for exports, e.g. to Southeast Asia and Africa. The Big Three domestic airlines still prefer large airplanes manufactured by Boeing and Airbus. It may also take some time for domestic consumers to accept Chinese airplanes. To make a breakthrough in the domestic market, airplane makers are setting up domestic airlines of their own. For example, Aviation Industry Corporation of China (AVIC) had formed a 95:5 JV with China Eastern Airlines, named Xingfu Airlines, to tap into the domestic market.

Aviation industry makes regional aircrafts ...

In long term, China's demand for regional airlines looks promising, as many 2nd and 3rd tier cities are building their own airports. Most of the current airplanes in China are relatively large, unsuited for shorter routes. As a result, domestic airlines often resort to wide-body aircrafts for short-haul flights. High-speed railway can be a long term threat to the regional airline business.

ARJ21-700 (70-90 passengers), the new short-range turbofan regional aircraft with independent intellectual property rights developed by China, has entered the flight test phrase, and is scheduled to get its certificate and deliver to customers in 2011. On Nov 17, 2010, at the Zhuhai Airshow, Commercial Aircraft Corporation of China (COMAC) received orders for 100 planes, bringing the total number of orders to 340 units.

Large airliners

... wide-body aircrafts ...

China has an ambition to make its own wide-body airplanes. The Large Aircraft Project, launched in May 2008 with the set-up of COMAC is one of the 16 major projects in the country's long-term science and technology development plan. According to COMAC chairman Mr. ZHANG Qingwei, China will invest some Rmb30bn in R&D and another Rmb30bn to build up the manufacturing capacity.

COMAC's first product, C919 (156-168 passengers), is designed to compete with Boeing 737 and Airbus A320. At the same Nov Zhuhai Airshow, it received 100 orders from six companies. If there is no delay, C919 will have its first flight in 2014 and its first delivery by 2016.

General purpose aircrafts

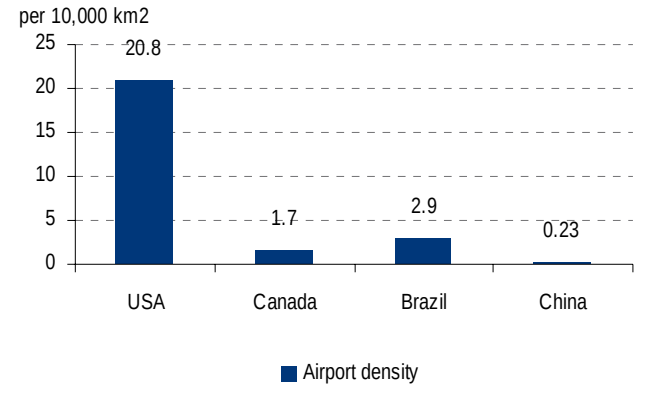
... and general purpose aircrafts

Recently, State Council and Central Military Commission (CMC) jointly issued an opinion on reforming low-altitude airspace management and released a timetable for the opening-up of low-altitude airspace: regional pilot test before 2011; national-wide promotion, 2011-2015; deepening the reform, 2016-2020.

In Aug 2010, the Civil Aviation Administration of China (CAAC) lowered landing fee by 40% and parking fee by 50% for general purpose aircrafts ("Airport landing fee cut", 25 Aug 2010).

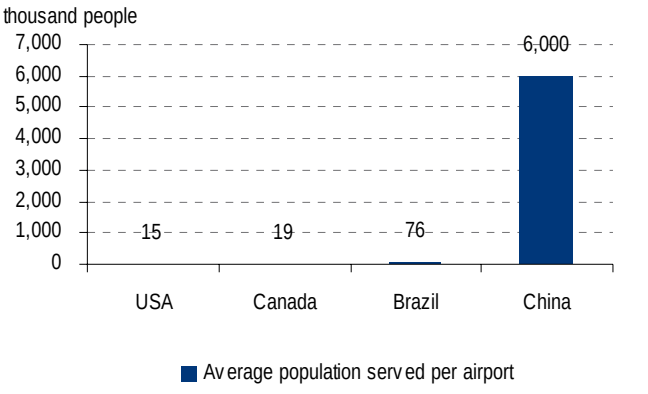
The breakthrough will remove some obstacles for the development of general aviation. Currently, China has 907 registered general aircrafts, 3,600 pilots, and 70 airports for general-purpose planes. In contrast, United States has 230,000 general aircrafts, 330,000 pilots, and 15,000 airports. The number of airport density also reveals the great disparity between China and developed countries. The huge gap indicates a huge potential (Chart 4.1 & 4.2).

Chart 4.1: Airport density comparison



Source: BofA Merrill Lynch Global Research

Chart 4.2: Number of people served per airport



Source: BofA Merill Lynch research

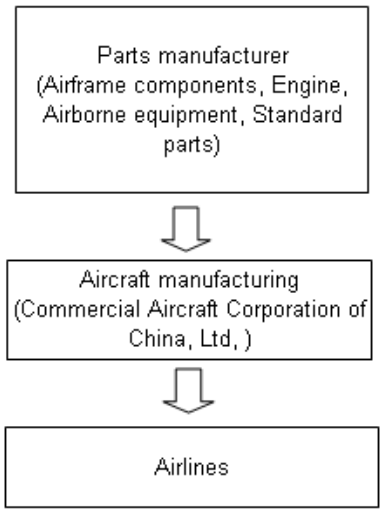
According to the estimation of CAAC, China will need about 10,000 units of general aircrafts in the next few years, which accounts for about 10% of the total global demand. With the development of China's economy, business flying, commercial flying, air tour, and private license training will become more popular, which should lead to a rapid growth of China's general aviation industry.

Key players along the value chain

The value chain of big airplane and regional airplane are the same (Chart 4.3). COMAC is the principal vehicle of China's Large Airplane Project, organizing the feasibility studies, conducting key technology research, and is responsible for overall design, system planning, and the making of large aircrafts. COMAC will outsource most of its components, relying on both domestic and international suppliers. For regional airplanes, the body parts are generally produced by domestic aircraft manufacturers while the engines, avionics, power systems, etc. are normally purchased via global tendering.

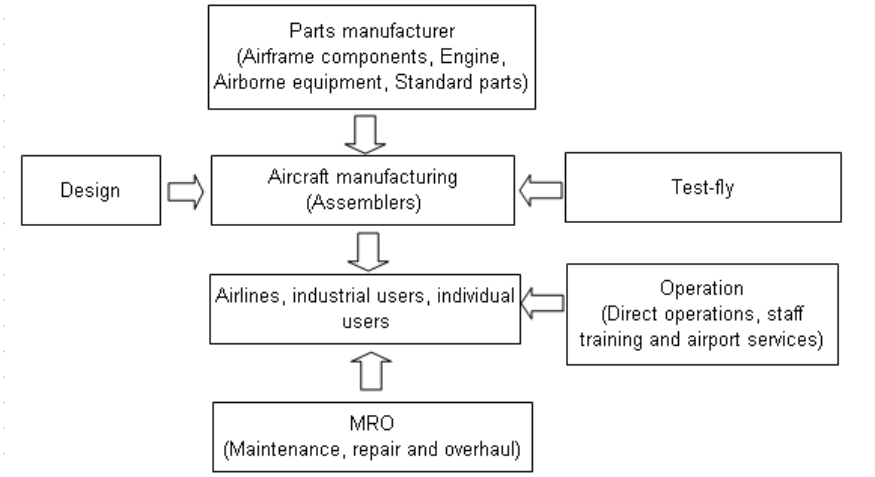
The value chain of general aviation industry is in Chart 4.4. It is fairly long, covering parts, assembling, operation, maintenance, airport and repair services. So the multiplier effect of general aviation's development should be quite high, one of the main reasons behind the government's decision to jump-start the industry in our opinion.

Chart 4.3: Value chain – big and regional airplanes



Source: BofA Merrill Lynch Global Research

Chart 4.4: Value chain – general aviation



Source: BofA Merrill Lynch Global Research

Table 4.2 contains a list of companies with exposure to the aviation sector in China.

Table 4.2: Exposures to aviation industry

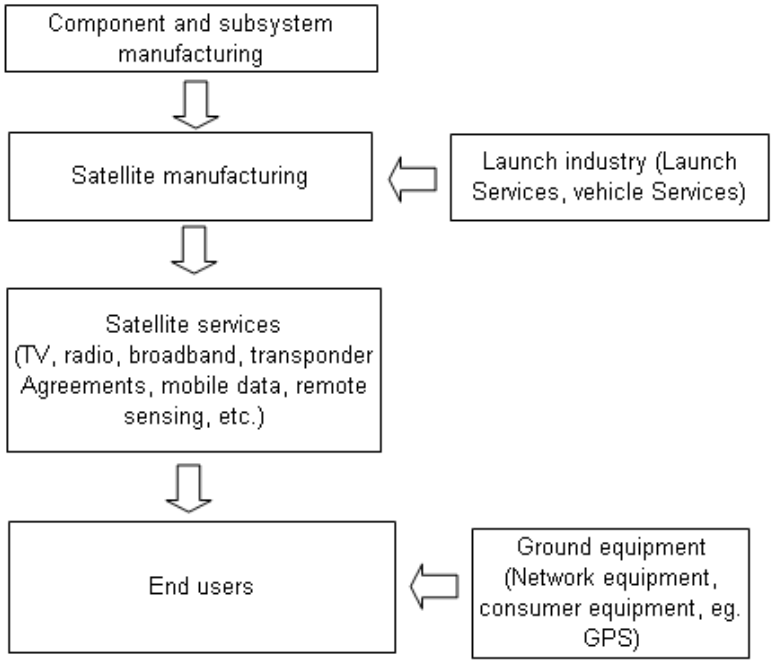
Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
2357 HK	AviChina	2.4	Aircraft maker	High	Makes aircrafts and parts (helicopters, trainers, general purpose aircraft and regional jets). Parent co is AVIC. Key products: Z-8, Z-9, Z-11 and HC-I20 series helicopters; K-8 series and CJ-6 trainers; Y-12 series multi-purpose aero planes and the N-5 series agricultural aero planes; EC-120 helicopters jointly produced by the Group and Eurocopter; CA109 helicopters jointly produced by the Group and Agusta; and ERJ-145 series regional jets jointly produced by the Group and Embraer- Empresa Brasileira de Aeronautica S.A.
000768 CH	Xi'an Aircraft Intl	4.6	Aircraft components	High	Key products are H-6 bombers, Flying Leopard fighter-bombers (JH series), MA60 regional airliners, and parts for ARJ series regional airliners.
600316 CH	Hongdu Aviation	3.0	Jet trainers	High	Jet trainers, agriculture planes, and general planes
600038 CH	Harfei Aviation	1.5	Helicopters	High	Helicopters, airplane parts, and aviation-related products. Its products include Z9, H425, HC120, and EC120 helicopters; and the Y12 airplane. It has a strategic alliance with Airbus S.A.S. for the joint manufacture of the A350 XWB jet plane in China.
600893 CH	Xi'an Aero-engine	2.6	Jet engines	High	Specialize in the manufacturing and maintenance of aero-engines. It's the only listed Chinese airplane engine maker.
000738 CH	AVIC Aero-engine controls	2.1	Engine control system	High	Aero engine control system products
600372 CH	China AVIC Avionics Equip	2.5	Aero electronics	High	By assets injection, the company extended it business from aviation lighting and control system to all the links of the airborne equipment value chain, including flight control, aircraft position, flight parameters, navigation, and sensors.
002013 CH	Hubei Aviation Precision	0.8	Precision punching products	High	Precision punching products and aviation electrical equipment.
002023 CH	Sichuan Haite High-tech	0.8	Aircraft repair	High	It repairs aircraft equipment, including wireless equipment, instruments, electrical equipment, and power equipment. The Company also develops and sells aircraft inspection equipment and technology.

Source: BofA Merrill Lynch Global Research

Satellite industry

Satellite is a key area of aerospace technology applications. Major applications include navigation, satellite TV and satellite communication. The satellite industry can be broken-down into four sectors: satellite service, satellite manufacturing, launch industry, and ground equipment (Chart 4.5).

Chart 4.5: Value chain -satellite



Source: BofA Merrill Lynch Global Research

Ground equipment and the satellite service normally generate ~90% of the total revenue of the industry.

China's own GNSS (北斗 Beidou)

In satellite, China is developing its own global positioning system, competing with GPS.

The US' GPS currently dominates the global market with a 95% market share roughly (Table 4.3). An over reliance on GPS is a threat to China's national defense and economic security. That's why the satellite navigation system is considered a priority by the Chinese government. Currently, US' GPS and Russia's GLONASS are the only two fully operational global navigation satellite system (GNSS). Europe's Galileo positioning system is scheduled to come on line in 2014. China's GNSS plan (Beidou) has 3 stages, i.e. experimental by 2003, regional coverage by 2012 with 10 satellites, and global coverage by 2020 with 35 satellites. By 2010, China has already launched 7 satellites and the 2nd stage targets will most likely be met in 2011, one year ahead of schedule.

Table 4.3: Comparison of GNSS systems

System	Country	Coding	Number of satellites	Status
GPS	United States	CDMA	⩾ 24	operational
GLONASS	Russia	FDMA/CDMA	24 (30 when CDMA signal launches)	operational with restrictions, CDMA in preparation
Galileo	European Union	CDMA	2 test bed satellites in orbit 22 operational satellites budgeted	in preparation
COMPASS/ Beidou	China	CDMA	35	5 satellites operational, additional 30 satellites planned

Source: BofA Merrill Lynch Global Research

Market opportunities

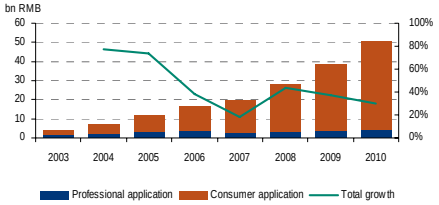
The value chain for navigation is long, encompassing manufacturing, software, terminal devices, geographic information collection and map services. Most of the devices and services are currently based on GPS but some companies are shifting to Beidou. The transition from GPS to Beidou will generate a huge market for the entire industry.

The satellite navigation market, especially the consumer application, has been growing very fast in China with a 54% CAGR over the past 7 years (Chart 4.6). Nevertheless, China is only ~2% of global navigation market, small compared to the developed countries, i.e. United States, Japan and EU, which account for almost 90% of global navigation market.

China's navigation market has a lot of room to grow. For example, China's consumer application of navigation is still at its early stage of development. Penetration rate for new cars is less than 2% in china, vs. almost 80% in Japan and 10% in U.S. Market potential is huge given that China is now the world's larges auto market.

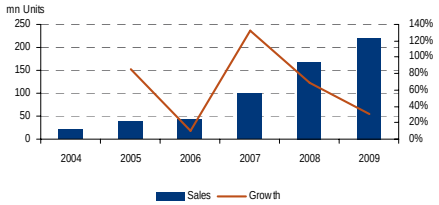
Another exciting area is Portable navigation device (PND), including in-car portable device, handheld portable receivers, and GPS-integrated mobile phones (Chart 4.7). Driven by the adoption of smart phones, GPS-integrated mobile phone and location-based services (LBS) are gaining popularity (Chart 4.8 & 4.9). For example, iPhone already has more than 6,000 LBS apps available.

Chart 4.6: Market size of satellite navigation application in China



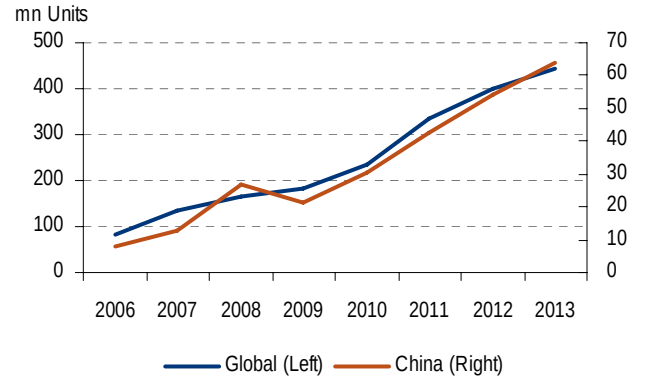
Source: UniStrong prospectus, BofA Merrill Lynch Global Research

Chart 4.7: PND sales in China



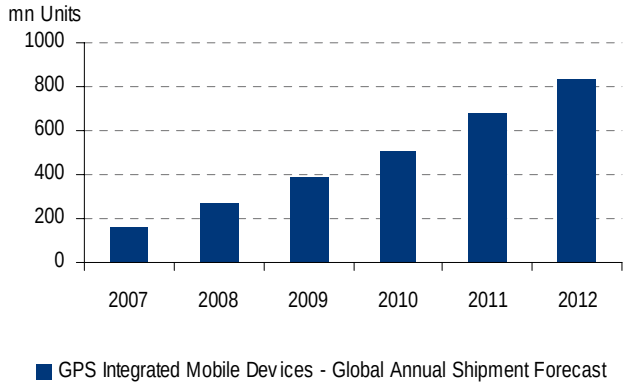
Source: BofA Merrill Lynch Global Research

Chart 4.8: Smart phone shipment forecast worldwide and in China



Source: iSuppli Corp, BofA Merrill Lynch Global Research

Chart 4.9: GPS integrated mobile devices - global annual shipment



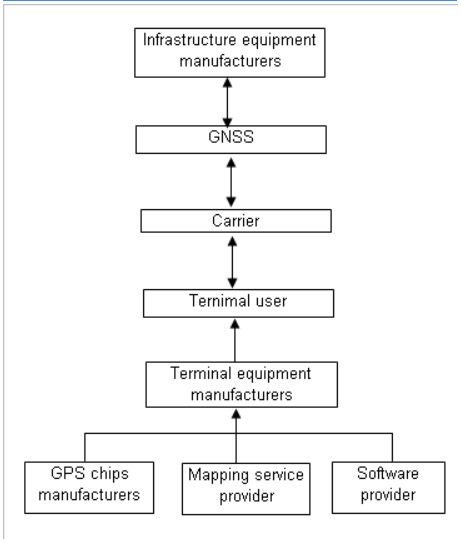
Source: GPS: A Path to New Applications on Mobile Devices, BofA Merrill Lynch Global Research

Listed companies with exposure to satellite

The value chain for navigation is shown in Chart 4.10.

There are listed companies with exposure to satellite equipment and navigation and they are included in Table 4.4.

Chart 4.10: Navigation value chain



Source: BofA Merrill Lynch Global Research

Table 4.4: Exposures to satellite industry

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
600118 CH	China Dongfanhong Spacesa	2.7	Satellite manufacturing	High	The only listed satellite manufacturing company.
600879 CH	China Aerospace Times Elec	1.7	Electronic parts	High	Electronic parts for the space industry.
300101 CH	Chengdu Goldtel Elec	1.2	Beidou terminal products	High	High-performance and reliability RF, baseband, video / image processing chip and the frequency synthesizer for China's home grown Beidou system; the company can produce wide range of Beidou based terminal products.
002151 CH	Beijing BDStar Navigation	0.7	Navigation	High	Specialize in navigation and positioning systems based on China's Beidou system, the company is a leading navigation product vendor for fishing, defense, mapping and ports (containers). The company not only sells navigation products, but also provides navigation services and charges the users on an annual or semi-annual basis.
002383 CH	Beijing Unistrong Science	1.0	Navigation	High	Satellite navigation and positioning products (car navigation, GIS data collection, mapping and etc.). It's technology is based on GPS, GLONASS, and China's Beidou.
002405 CH	Navinfo	3.3	E-map	High	The products are mainly for auto navigation, consumer electronic navigation (GPS mobile navigation map) and the electronic map services.
300036 CH	Beijing Supermap Software	0.4	GIS	High	Geographic information system (GIS) software company. The company sells its products to both end users and re-developers.

Source: BofA Merrill Lynch Global Research

High-speed railway

China is rolling out a high-speed railway network with many self-developed technologies.

High-speed railway is listed as a key development area in the high-end equipment part. In our opinion, growth of China's railway construction may have peaked given the high base, but locomotives, railcars and parts have more room to grow given the lag in CAPEX and export potentials.

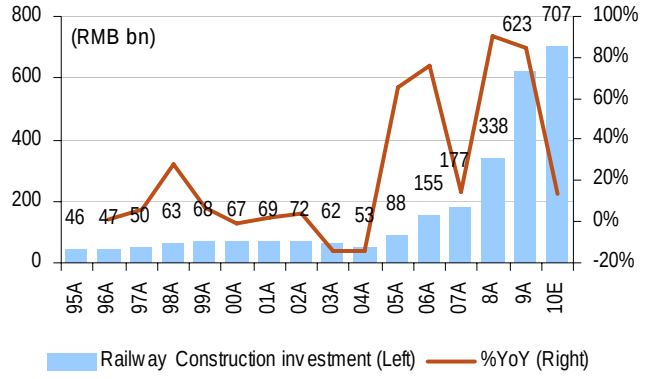
Exhibit 4.2: China's high speed railways

Source: BofA Merrill Lynch Global Research

Infrastructure investment may have peaked

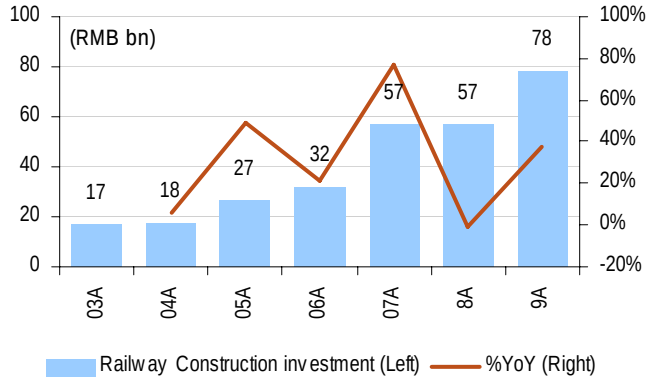
Partly promoted by the need for economic stimulus during the global financial crisis, the Chinese government has approved many mega high-speed railway projects since 2009. Most of these projects have already commenced construction, and are scheduled for completion from 2011 to 2014. China budgeted to spend Rmb700bn+ in railway construction in 2010 alone, almost doubled the total investment during the entire 10th Five-Year Plan period (2001-2005) - Chart 4.11. We believe that, although total investment may continue to grow moderately for a short while, growth rate is set to decelerate sharply. As a result, we suggest investors to focus on equipment and service suppliers rather than contractors for future growth potential (Chart 4.12).

Chart 4.11: China's railway investment



Source: MOR, Merrill Lynch Research

Chart 4.12: China's railcar investment



Source: MOR, Merrill Lynch Research

Leading technology

China is the first and only country so far to have commercialized high-speed train service on conventional rail lines that can reach 350 km/h. On Dec 3, 2010, trains on Beijing-Shanghai High Speed Rails reached top speed of 486.1 km/h during a test run, a new world record, showcasing China's strength in railway technology (Table 4.5). The train used in this test, CRH380B, is made by Changchun Railway Vehicles. China's earlier high speed trains were built largely under technology transfers from foreign manufacturers including Siemens, Bombardier, Alstom and Kawasaki Heavy Industries but it has developed many of its own in recent years.

Table 4.5: High speed railway technology comparison

	China	Japan	France	Germany
Top speed (km/h)	350	300	320	300
Technology	200-200km/h foreign 350km/h proprietary	Proprietary	Proprietary	Proprietary
Rail	100% ballastless	Partly ballastless	Ballasted	Partly ballastless

Source: MoR, BofA Merrill Lynch Global Research

There are three major bullet train makers in China: China CNR, China South Locomotive, and BST (a JV between China South Locomotive and Bombardier). China CNR has about 20% market share, China South Locomotive 40%, and BST 40%. BST dominates the 200-250 km/h market, while China CNR and China South Locomotive dominate the 300-250 km/h market. China CNR has close to 50% market share in the 300-350 km/h market.

Listed exposure to high-speed rail

There are listed companies with exposure to railway construction, equipment manufacturing and railway operating. As stated earlier, thematically we find equipment makers the most interesting.

Contractors

China Railway Group (390 HK) and China Railway Construction (1186 HK) are the most important contractors for railway construction. CCCC (1800 HK) also has some exposure.

Rolling stock & parts

Jinxi Axle (600495 CH) supplies train axles; GEM-year (601002 CH), fasteners; Maanshan (323 HK), wheels; Midas (1021 HK) and Zhong Wang (1333 HK), extruded aluminum products used to produce railcars; Zhuzhou Times New Materials (600458 CH), macromolecular elastic materials used to reduce the vibration and noise of trains and vehicles; Zhuzhou CSR Times Electric (3898 HK), integrates train-borne electrical systems.

Railway operators

Daqin Railway (601006 CH) operates mainly coal lines in the north while, Guangshen Railway (6010333 CH), passenger lines in the south.

Other exposures

There are many other listed companies that have railway related revenues, but most of them are not pure plays, i.e. steel/cement companies, steel structure vendors (for railway stations), electrical and electronics product vendors (for trains).

Offshore Engineering

Offshore engineering is another targeted area.

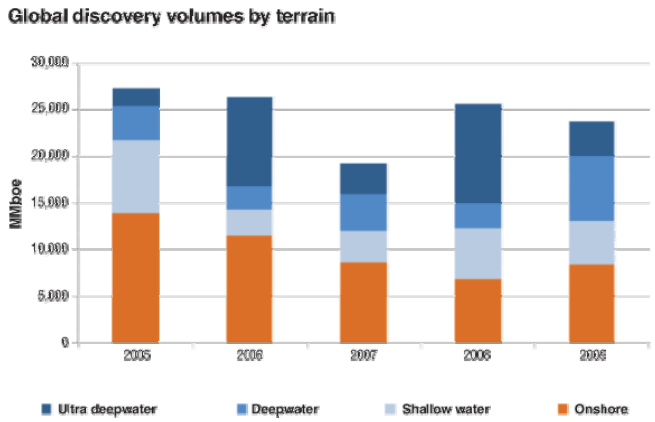
Oil and gas play a central role in marine equipment. With the rapid depletion of onshore resources, offshore drilling is becoming more important. Offshore oil equipment includes various types of drilling platforms, production platforms, floating production storage vessel, unloading oil tankers, floating cranes, pipe-laying ship and diving vessels.

Abundant offshore sources to be uncovered

In recent years, most of the newly discovered oil fields were under the sea - from 2005-2009, newly discovered offshore oil fields accounted for almost 60% of the total oil fields found in volume terms (Chart 4.13). The 18,000 km of coastline and 3 million km2 of waters of China are rich in ocean resources. Some estimate that

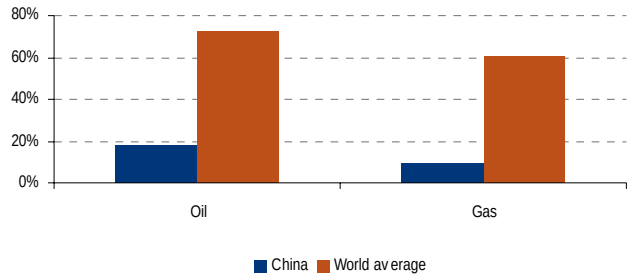
there are about 24bn tons of oil and 14tr m3 of natural gas reserves in China's inshore areas. So far, the discovery rate is only 18.5% for oil and 9.2% for natural gas in China, much lower than the world average of 73.0% and 60.5% respectively (Chart 4.14). As a result, the development of offshore engineering equipment is of great strategic significance and has become a national priority.

Chart 4.13: Global discovery volume by terrain



Source: Global overview of offshore oil & gas operations for 2005-2009, BofA Merrill Lynch Global Research

Chart 4.14: Offshore resources discovery rate

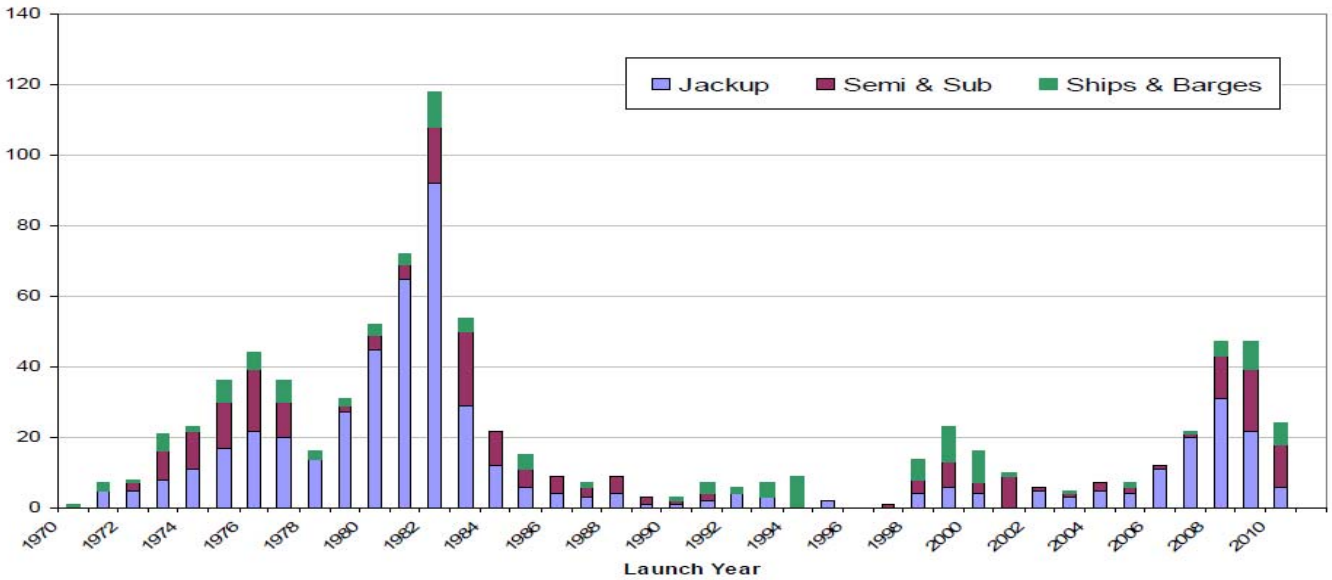


Source: China Petroleum & Petrochemical Equipment Industry Association (CPEIA), BofA Merrill Lynch Global Research

Assisted by high oil price and advance in technologies, offshore drilling is going deeper waters. China's deep water drilling is at an early stage. Given China's desire to accelerate the development of offshore resources, there is an urgent need to develop its own offshore engineering technologies, especially deepwater.

In addition, China can use its manufacturing prowess to tap into the global replacement demand. The last peak in delivery of offshore equipment was in the early 80s and many of them are approaching retirement age (Chart 4.15).

Chart 4.15: The deliveries of offshore engineering equipments 1970-2010



ource: SHANGHAI BESTWAY MARINE ENGINEERING DESIGN CO., LTD. Prospectus, BofA Merrill Lynch Global Research

Urged on by the government

First tier offshore engineering equipment vendors are mainly from Europe and US, dominating the high-end equipment market. Second tier players are from Korea and Singapore, dominating assembly and construction. Chinese players currently mainly focus on the low-end. As Table 4.6 shows, the Chinese government has greatly strengthened its support to the offshore engineering sector in recent years with various policy supports, including special funds.

Table 4.6: Policy summary

Date of issue	Document	Content
2003	National marine economy development plan	To greatly develop offshore oil and gas industry, shipbuilding and repairing industry
2006	Opinions on speeding up the revitalization of equipment manufacturing industry	To develop large-scale offshore engineering equipment, 300,000-tons-level ore and oil transport ships, FPSO, large capacity container ship, LNG carriers and other high-tech, high value-added ships and high-power diesel engines, etc.
2009	Restructuring and rejuvenation plan for the shipbuilding industry	To support the R&D of high-tech ships and offshore engineering equipment by arranging a special fund for industrial revitalization and technological transformation.
2009	Detailed plan for the restructuring and revitalization of shipbuilding industry	To speed up the innovation of offshore engineering equipment industry; to strengthen the technological transformation and the R&D of key technologies and new products; to improve the level of corollary equipments for ships, develop offshore engineering equipments, and improve the competitiveness in the international markets; to have 10% of the international offshore engineering equipment market by 2011; to support the R&D of new jack-ups, submersible drilling rigs and production platforms, FPSOs, workboat, large-scaled modules, and other comprehensive integrated marine engineering equipments; to encourage the research on offshore engineering and power transmission system, single-point mooring system, dynamic positioning system, deep-diving equipment, deck machinery, oil and water treatment and desalination system and other critical systems and corollary equipments
2009	Guidance for the R&D projects of offshore engineering equipments (first batch)	To vigorously develop offshore engineering equipments is a strategic way to deal with the financial crisis, to further readjust industrial structure, to expand development space, and to support new economic growth point

Source: BofA Merrill Lynch Global Research

By the end of the 12th Five-Year Plan, i.e. 2015, China wants its offshore engineering equipment industry to reach Rmb100bn in yearly output, some 20% in global market share. It aims to build four industry bases with Rmb20bn each in annual outputs and 5-6 general contractors with Rmb15bn in annual outputs. Mr. JIN, Xiaojian, the general manager of China National Offshore Oil Corp (CNOOC) engineering construction department estimated that, in order to achieve the government's goals, an additional 50mn tons of offshore capacity will be installed and 2-3 deepwater oil and gas fields will be put into operation, and the total investment may reach Rmb250-300bn.

Exposures to the offshore market

Table 4.7 lists some of the companies with exposure to the offshore market.

Table 4.7: Exposures to off-shore engineering equipment manufacturing industry

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
600320 CH	Zhenhua	4.1	Offshore engineering vessels	High	A global leader in port machinery. Offshore engineering is also one of its main businesses; key products are large floating cranes, pipe laying vessels and other engineering vessels, all types of platforms and DP system.
600583 CH	Offshore Oil Engineering	4.8	Offshore engineering contractor	High	Contractor for offshore oil and gas projects. It engages in the design and construction of offshore oil and gas exploration and production projects and their onshore terminals; construction and installation of wharf steel structures; designing and laying submarine pipelines and cables; ship loading, transportation, installation, and commissioning of jacket platforms; and testing and maintenance of offshore and onshore facilities.
2883 HK	China Oilfield Services	15.1	Offshore oilfield services	High	Drilling services, well services, marine support and transportation services, and geophysical services
300008 CH	Shanghai Bestway Marine	0.4	Marine product designs	High	Provides marine product designs (transport ships, passenger ships, special ships, and offshore engineering ships), including proposal design, basic design, detail design, and production design.
600150 CH	China CSSC	6.9	Shipbuilding	High	A leading shipbuilding/ repairing company in China. It builds bulk ships, tankers, semi-submersible drilling platforms, and etc. It also builds ship engines.
601989 CH	China Shipbuilding Industry	12.5	Ship parts	High	Builds parts for the shipbuilding industry, including engines and parts, auxiliary engines and transportation equipment.

Source: BofA Merrill Lynch Global Research

So is smart manufacturing equipment.

Intelligent Manufacturing Equipment

Intelligent manufacturing equipment, particularly CNC machine tools (computer numerical control machine tools), was singled out as a key development area for the high-end equipment industry. As a result of China's industrialization and rising labor income, demand for high efficiency / precise machine tools is rising fast.

Import substitution promising

Chinese machine tool makers have been upgrading their products with numerical rate, i.e. the percentage of CNC machine tools, of China's machine tools reached 53.2% by the end of 2009. Nevertheless, the ratio is still much lower than developed countries' 80%-90%. Besides, most high-end CNC machine tools are still imported.

Based on the targets set in the "high-end CNC machine tools and basic manufacturing equipment projects" in China's "Long-term Scientific and Technological Development Plan (2006 ~ 2020)", the localization rate of the high-end CNC machine tools needed for aerospace, marine, automotive, power generation industries is expected to exceed 80% by 2020.

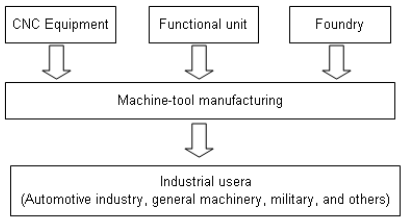
With the improvement of domestic technologies, the technical gap between domestic players and international ones is narrowing. Import substitution market looks promising in our opinion given the cost advantage of domestic suppliers.

Listed companies with digital machinery exposure

Chart 4.16 shows the value chain in the industry.

Table 4.8 lists some companies with exposure to intelligent manufacturing machinery market.

Chart 4.16: Value chain – intelligent manufacturing equipment



Source: BofA Merrill Lynch Global Research

Table 4.8: Exposures to intelligent manufacturing equipment industry

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
300 HK	Kunming Mahchine Tool	0.7	CNC tools	High	It makes machine tools, precision measuring equipment and precision transducers.
000410 CH	Shenyang Machine Tool	1.0	CNC tools	High	It makes machine tools with a dominant market share in traditional machine tools. It is trying to increase the percentage of CNC machine tools in its product mix. CNC currently contributes to about half of its revenue and more than 70% of its profit.
000837 CH	Qinchuan Machinery	0.7	CNC tools	High	It produces numerically controlled gear grinders, plastics machinery, gears, and hydraulic pressed products.
002248 CH	Weihai Huadong Automation	1.1	CNC tools	High	It produces CNC systems and CNC machine tools. Its products include gantry machine, vertical machining center, horizontal machining center, drilling and tapping machining center, NC lathel/turning center, floor type boring and milling machine, NC milling machine, universal cylindrical machine, CNC cylindrical grinder, CNC vertical grinder, surface grinder and milling machine.
300024 CH	Siasun Robot & Automation	1.3	Industrial robots	High	It makes various industrial robots and automated equipment. Products include automated assembly production lines, automated testing production lines, automated checking production lines, and other complete set equipment; and material handling products, such as AGVS, RGVS, stacker cranes, palletizing robots, material handling automatic conveyors and automated work equipment, material handling systems, and logistics control and management systems.

Source: BofA Merrill Lynch Global Research

New Energy

In the announcement, the State Council highlighted a few areas for focused development: next-generation nuclear power technology, nuclear power plants with advanced technology; solar power; wind power equipment, large-scale wind power plants, smart grid and related systems that can accommodate new energy sources; bio-energy; and smart grid (Table 5.1).

Table 5.1: New energy sector overview

Targeted areas	Policies	Relevant stocks
Next-generation nuclear power technology, nuclear power plants with advanced technology (新一代核能技术和先进反应堆)		Equipment vendors: Harbin Power (1133 HK), Dongfang (600875 CH/1072 HK), Shanghai Electric (601727 CH/2727 HK) Forging systems: China First Heavy (601106 CH), China Erzhong (601268 CH) Equipment vendor: Auto Electric Power (002227 CH), Shentong Valve (002438 CH), SUFA Tech (000777 CH), Orient Zirconic (002167 CH), Shanghai Automation (600848 CH), Tianwei Baobian (600550 CH), Fangda Carbon New Material (600516 CH), Nanfeng Ventilator (300004 CH), Dun'An Artificial Environment (002011 CH), Baoji Titanium (600456 CH), Lantai (600328 CH), Hailu Heavy Industry (002255 CH), Xiangtan Electric (600416 CH), Guodian Nanjing Automation (600268 CH), Harbin Air Conditioning (600202 CH), Atlantic China Welding (600558 CH) Nuclear power plants: Shenergy (600642 CH), Anhui Wenergy (000543 CH)
Solar power (太阳能)	Government investment in infrastructure, compulsory new energy targets on IPPs, tax benefit, subsidies, local content requirement, preferential electricity purchase price, off-take guarantee.	Poly silicon: GCL Poly Energy (3800 HK), Jinggong Science & Tech (002006 CH), CSG (000012 CH), Leshan Electric Power (600644 CH), Minjiang Hydropower (600131 CH), Tianwei Baobian (600550 CH), Chuantou Energy (600674 CH), Jiangsu Sunshine (600220 CH), Aerospace Automobile (600151 CH), Dun'An Artificial Environment (002011 CH), Tongwei (600438 CH), Lengguang Industrial (600629 CH) Solar wafer: GT Solar (SOLR US), Shanghai Comtec Solar (712 HK), JinkoSolar (JKS US), ReneSola (SOL US), JA Solar (JASO US), LDK Solar (LDK US), Canadian Solar (CSIQ US), Grinm Semiconductor (600206 CH), Zhonghuan Semiconductor (002129 CH) Silicon cell/module: China Solar Energy (155 HK), China Gogreen (397 HK), Apollo Solar (566 HK), Suntech Power (STP US), China Sunergy (CSUN US), Solarfun Power (SOLF US), Trina Solar (TSL US), Yingli Green Energy (YGE US), Jetion Solar (JHL LN), New Huaguang (600184 CH), Aerospace Automobile (600151 CH), TBEA (600089 CH), Sunvim (002083 CH), Topraysolar (002218 CH), Sanan Optoelectronics (600703 CH), Jiangsu Zongyi (600770 CH), Yin Xing Energy (000862 CH), Hengdian Magnetics (002056 CH), Fengfan (600482 CH), Ningbo Shanshan (600884 CH) Parts & software: Unionmet Singapore (UMS SP), Tianwei Baobian (600550 CH), Linuo Solar (600885 CH), Fangyuan Slewing Ring (002147 CH), Guangdong Macro (000533 CH), Guodian Nanjing Automation (600268 CH), Tianlong Photoelectric (300029 CH), Xindaxin Materials (300080 CH) Solar power plants: Longyuan Power (916 HK) Solar powered products: China Singyes Solar (750 HK), China Technology Dev (CTDC US)
Wind power equipment, wind power plants, smart grid and related systems that can accommodate new energy sources (风电技术装备，风电规模化发展，适应新能源发展的智能电网及运行体系建设)		Key parts: Goldwind (2208 HK/002202 CH), China High Speed (658 HK), Longyuan (916 HK),China Wind Systems (CWS US), Greatwall Electrcal (600192 CH), Xinmao Science & Tech (000836 CH), Jiangsu Miracle (002009 CH), Tianwei Baobian (600550 CH), Sinoma Science & Tech (002080 CH), Times New Material (600458 CH), Nanfeng Ventilator (300004 CH), Fangyuan Slewing Ring (002147 CH), Tianma Bearing (002122 CH), Jiuding New Material (002201 CH), Xinjiang Huitong (000415 CH), Hi-Tech Control (002184 CH), Huarui Casting (002204 CH), Sichuan CRUN (002272 CH), Guodian Nanjing Automation (600268 CH) Wind turbine: Ming Yang Wind Power (MY US), Longyuan (916 HK), A-Power Energy (APWR US), Renewable Energy Asia (REAG SP), Dongfang Electric (600875 CH/1072 HK), Shanghai Electric (601727 CH/2727 HK), Xiangtan Electric (600416 CH),TBEA (600089 CH), Huayi Electric (600290 CH), Changzheng Electric (600112 CH) Wind power plants (wind farm): China Power New Energy (735 HK), China WindPower Group (182 HK), China Wind Power Intl. (CNW CN), Northwest Inv (NWIG LN), Yin Xing Energy (000862 CH)
Bio energy (生物质能)		Biomass power: Wuhan Kaidj (000939 CH), GuangDong Shaoneng (000601 CH), DP CleanTech (not listed) Garbage power: Wuxi Huaguang (600475 CH), China Everbrite International (0257 HK) Bio-fuel: Gushan (GU US)
Smart grid (智能网)		Raw material: Wuhan Steel (600005 CH), Jiangxi Copper (358 HK/600362 CH) Equipments: China Titans Energy (2188 HK), Boer Power (1685 HK), China Shoto PLC (CHNS LN), TBEA (600089 CH), Tianwei Baobian (600550 CH), China XD (601179 CH), XJ Electric (000400 CH), Rongxin Electronic (002123 CH), Tellhow Sci-Tech (600590 CH), Dongfang Electronics (000682 CH), Guodian Nanjing Automation (600268 CH), NARI Tech (600406 CH), Changzheng Electric (600112 CH), Huayi Electric (600290 CH), Yinhe Hi-Tech (000806 CH), Clou Electronics (002121 CH), Xiangtan Electric (600416 CH) Smart components: Sieyuan Electric (002028 CH), Dongyuan Electrical (002074 CH), Pinggao Electric (600312 CH)

Source: BofA Merrill Lynch Global Research

New energy is strategically important

New energy is strategically important to China because …

One of the key goals of the government during the 12th Five-Year Plan period (2010-2015) is to shift energy mix from coal to other sources, such as gas, wind, hydro and nuclear (Thomas Wong/Angello Chan/team, "Long March to Green: 12th FYP of Energy Sector", 30 Nov 2010). This will benefit the environment, help China to diversify its energy sources, reduce reliance on energy imports and boost exports.

We have discussed extensively in the "Energy Saving & Environmental Protection" section why China wants to reduce its energy intensity from an environmental perspective. We'd like to highlight a few additional issues here that are behind China's resolve to increase the use of new energy.

Too coal centric

… it helps to reduce pollution …

About 70% of China's energy consumption comes from coal, much higher than the rest of the world (Table 5.2). Coal burning is China's largest source of green gas emission.

Table 5.2: Top 20 energy consumption country primary fuel mix

Country	Oil	Nat. Gas	Coal	Nuclear	Hydro
United States	39%	27%	23%	9%	3%
China	19%	4%	71%	1%	6%
Russia	20%	55%	13%	6%	6%
India	32%	10%	52%	1%	5%
Japan	43%	17%	23%	13%	4%
Canada	30%	27%	8%	6%	28%
Germany	39%	24%	25%	11%	1%
France	36%	16%	4%	38%	5%
South Korea	44%	13%	29%	14%	0%
Brazil	46%	8%	5%	1%	39%
Iran	41%	58%	1%	0%	1%
United Kingdom	37%	39%	15%	8%	1%
Saudi Arabia	64%	36%	0%	0%	0%
Italy	46%	39%	8%	0%	6%
Mexico	52%	38%	4%	1%	4%
Spain	55%	23%	8%	9%	5%
Indonesia	48%	26%	24%	0%	2%
South Africa	19%	0%	78%	2%	0%
Australia	36%	19%	43%	0%	2%
Ukraine	12%	38%	31%	17%	2%

Source: BP Statistic Review 2010, BofA Merrill Lynch Global Research

Too reliant on imports

… lessen China's reliance on energy imports …

New energies, often generated locally, will help China to diversify its energy sources and incrementally reduce its reliance on imported energy, e.g. oil. So it's not just an economic or social issue but also a strategic issue of risk management.

2009 marked a turning point in China's oil industry. For the first time over the past 28 years, China registered the first YoY drop (-3%) in domestic crude output (189mt), according to the National Bureau of Energy. And for the first time in history, China relied on net imports for over half its oil consumption ("Drop in crude output", 4 Feb 2010) and about 80% of China's oil imports are shipped via the Malacca Strait. Energy security is paramount in top leadership's mind.

Developing a new source of high value-add exports

… and create more export opportunities.

On a third level, as China's emerging dominance in global supply of solar panels and wind turbines can attest, new energy related business can be good source of exports for China. On this, China is going down a well-travelled route, leveraging of its domestic market to develop internationally competitive champions, e.g. the high-speed train and power equipment.

Ambitious targets

China has ambitious targets for new energy …

In September 2009, during the UN Climate Change Conference, President Hu vowed to increase the percentage of China's non-fossil fuel to at least 15% of its total energy consumption by 2020. In the draft 12th Five-Year Plan for the energy sector, NDRC targets to have 19.3% of China's primary energy supply coming from non-coal/oil sources by 2015 (Table 5.3) with natural gas, wind, nuclear, bio power and solar all registering double digit CAGR between 2009 and 2015.

Table 5.3: Energy development targets for 2015

Sector	2009	2015E	CAGR
Coal (mn tons)	3,020	3,800	2%
Oil (mn tons)	380	500	3%
Natural gas (bn cbm)	89	260	10%
Hydro power (GW)	196	280	3%
Wind Power (GW)	26	90	12%
Nuclear power (GW)	9.1	30	11%
Bio Power (GW)	N.A.	13	N.A.
Solar PV (GW)	0	5	N.A.

Source: NDRC, BofA Merrill Lynch Global Research

Table 5.4: China energy consumption structure, 2015E

(mn tons of standard coal)	2015E	%
Total fossil energy	4,200	100%
Coal	2,686	64.0%
Ex-coal	1,514	36.0%
Oil	700	16.7%
Natural gas	320	7.6%
Nuclear Power	68	1.6%
Non-fossil	346	8.2%
Hydro power	267	6.4%
Wind Power	57	1.4%
Bio Power	20	0.5%
Solar Power	2.4	0.1%

Source: NDRC, BofA Merrill Lynch Global Research

Favorable government policies

… backed up by many favorable policies.

We have detailed many of the government's initiatives to reduce energy intensity and improve environmental protection in the "Energy Saving & Environmental Protection" section. We'd like to highlight some new energy specific policies here:

- Favorable tariffs: starting from 2006, China imposed an Rmb0.001/Kwh surcharge on coal-fire electricity, and has gradually increased it to Rmb0.004/Kwh by now. The proceeds are used to subsidize electricity purchase by the grid from new energy sources. Also China recently reformed its on-grid tariff pricing mechanism for wind power, adopting a more uniformed pricing structure that continues to offer attractive premiums over coal-fired power.

- Tax benefits: Most of the new energy related companies can enjoy tax concessions including breaks on corporate tax. For example, wind farms generally enjoy a 50% VAT refund, three years of corporate tax exemption plus three more years at 50% of the standard rate.
- LCR (Local content ratio) requirements: The government requires certain percentage of the value of new energy equipments to been made in China when awarding government projects. Foreign vendors have to form JVs with local manufacturers in order to meet the requirements. For example, between 2005 and 2009, the government required all wind farm constructions in China to have at least 70% wind turbine components (by value) manufactured domestically. On 22 Jan 2010, the government required that developers of offshore wind farms to be Chinese enterprises or Sino-foreign JVs controlled by Chinese investors (with >50% equity interest).
- Equipment subsidies: in some pilot test programs, the government offered to subsidize equipment purchases, e.g. the Golden Roof Project.
- Local governments' support: they may provide additional benefits including cheap land, access to loans and tax rebate.
- In some exceptional cases like biomass power, the government may even subsidize materials purchase.
- The government may foot the upfront investment to better accommodate new energy sources, e.g. power grid to accommodate wind and solar power.

In the future, the government may set compulsory new energy targets for IPPs, e.g. new energy/coal-fire ratios; order the power grid to accept more new energy; and further raise the relative costs of traditional energy.

A key risk is trade friction. On Dec 23, 2010, the US filed complaints with the WTO, complaining that China's "Wind Power Equipment Industry Development Fund" only subsidizes Chinese firms.

New energy cost comparison

From a cost perspective, hydro, nuclear and wind look the most promising …

Currently and without subsidy, hydro is the cheapest energy source by far, followed by coal-fired, nuclear, wind, biomass and solar. Nuclear is similar in cost to coal-fired. Wind is normally 40%+ more expensive than coal-fired, depending on location. Biomass cost is at least double that of coal-fired. Solar power is the most expensive, at least triple that of coal-fired (Table 5.5).

Table 5.5: Cost/price comparison among new and traditional energy sources

	Cost		Feed-in price		Cost analysis
	Cost (Rmb/Kwh)	Compared to coal-fired	Price (Rmb/Kwh)	Compared to coal-fired	
Hydro	Operating cost very low	Lower	0.148-0.395 Average ~0.27	Over 20% discount	Operational cost very low (1/5-1/10 of that of coal-fired typically); upfront investment is high, including plant and equipment, residents' relocation expenses; generation weather dependent.
Coal-fired	0.26 - 0.27		0.258-0.44 Average ~0.35		Coal price the biggest driver of operating costs; environment related costs going up.
Nuclear	N.A.	Similar	0.39-0.49 New plants will be lower	Similar or slightly higher	Short term cost may decline due to substitution of imported equipment; long term cost depends on uranium.
Wind	0.42-0.72	At least 40% higher	0.51-0.58	At least 40% higher. (Best location wind farm's cost is only less than 20% higher vs. top spectrum cost of coal-fire plants.)	Equipment cost may decline, but room limited.
Biomass	N.A.	At least double	0.6-0.75	Double	Cost may increase (collection and transportation of biomass fuel is energy and labor intensive).
Solar	0.7-2	At least triple	> 1	At least triple	Equipment cost may decline, but room limited; short term cost decline hinges on price of silicon which appears over supplied; long term cost decline hinges on technology breakthrough, i.e. thinner wafers and higher energy transmission efficiency.

Source: BofA Merrill Lynch Global Research

… after taking into account current cost structure and …

Current cost structure

Cost of **hydro**, wind and solar is mainly upfront investment. Operational cost of hydro power is very low and normally stable. Operational cost of wind and solar is not high either but is influenced by location and equipment quality (maintenance etc.).

Cost of **coal-fired**, nuclear and biomass is upfront investment + fuel cost + operational cost; fuel cost is a lot more important here and we suspect all fuel costs will likely go up in the long term.

Another cost for **wind** and **solar** is grid connection and transmission cost, which will most likely be taken up by the government owned power grids. Wind and solar power resources are often more abundant in remote areas; also the unstable nature of wind and solar power generation requires power grid upgrade.

… and future cost trend.

Future cost trend

Project cost of future **hydro** power plants should go up due to rising resident relocation, construction and environment related costs.

Overall **wind** power cost should be declining because of declining equipment cost (economy of scale, higher energy transmission efficiency).

Long term **solar** power cost should decline as well as equipment cost comes down, i.e. economy of scale, higher energy transmission efficiency, thinner silicon wafers etc. In general, solar power cost is harder to predict than wind. Silicon is by far the most important cost (~50%, or even 70% when price is high) for solar power equipment. Silicon price is very volatile (although it appears that downside from the current level is more likely due to over capacity). Besides, silicon production itself is very energy intensive. Thinner silicon wafers (less raw materials required) and better transmission efficiency will hinge on technology development, which is hard to predict.

Nuclear cost is relatively stable. Currently variable cost (fuel and operation) of nuclear power is similar to coal-fired power. Nuclear power station's upfront investment is higher than coal-fired power, and it takes longer to build, i.e. 6 years

vs. 3 years. Per KW capex of nuclear power is ~3x that of coal-fired power. But nuclear power plants' useful life can double coal-fired ones. On balance, considering useful life, nuclear power per KW capex is still at least 50% higher than that of coal-fire power. In short to mid term, nuclear cost may decline due to lower equipment cost (import substitution).

In terms of variable costs, nuclear power's operating cost is almost as high as fuel cost. But coal-fire power's variable cost is largely fuel cost.

Long term fuel cost is less visible, depending on uranium prices. Please note China has recently made a breakthrough in nuclear fuel pre-processing, which may potentially increase the utilization efficiency of nuclear fuel by ~60x. But fuel unitization improvement hinges on the development of 4G technology, which is probably 20 years away in terms of commercial use. We will have more discussions in the nuclear section.

Coal-fired cost is rising, mainly due to rising coal prices and more stringent environmental standards. Coal is by far the most important cost for coal-fired electricity (~70%). Despite periodic government interventions, coal prices have been moving up every year in China in recent years. Coal mining cost itself is rising as operations continue to go deeper underground; transportation cost is escalating, partly because supply is increasingly shifting to the western regions; rising labor cost and higher safety standards also lift mining cost; in long term, rising environmental charges including taxes and restoration costs may play an important role. Please note our metals and mining team is mid term cautious on coal prices, see Yongtao Shi's report: "Party is over, downgrade Chinese coal sector", Nov 30, 2010.

In theory, **biomass** power cost should be very low, but in reality it's quite high. Although equipment cost is declining because of import substitution, fuel cost is a major issue. Despite having abundant fuel supply because of China's big agriculture base, collection/storage cost of biomass fuel is high, resources are scattered and the supply is unstable. Collection and transportation of biomass fuel is energy and labor intensive so it's likely that biomass fuel cost may constantly rise in the future.

Nuclear power

Nuclear power is reliable.

Among the main new energy sources, nuclear appears to be the most reliable provided long term uranium supply can be secured and the safety issue is adequately addressed.

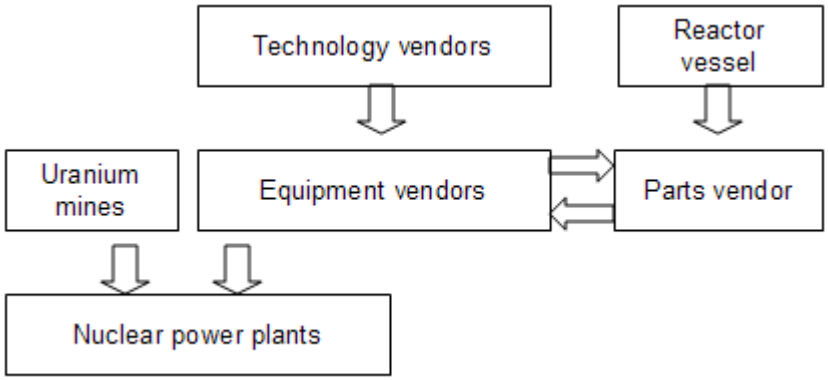
We believe a rising LCR, driven by technology transfer and substantial investments in equipment and component makers, will help to accelerate the adoption of nuclear power in China. If the third generation (3G) nuclear technology, especially AP1000, proves successful in China, it will likely increase the LCR further because domestic equipment makers appear ready to replace foreign vendors. This should help to reduce overall nuclear power cost significantly in China.

China currently has approved the construction of ~37GW nuclear power capacity (of which, ~28GW already commenced). According to NDRC's long term plan for the industry, nuclear power will reach ~70GW by 2020, representing 5% of total power generation capacity in China; that ratio may rise to 10% by 2030; and the total capacity may reach 500GW by 2050 (vs. a global capacity of 372GW in 2009).

Key players along the value chain (Chart 5.1)

Among the potential exposures, we like forging and uranium the most. Forging has a very high entry barrier, thus high margins and limited competition; resources, by definition, have a limited supply. Some small niche players with very specific technologies may also become big winners.

Chart 5.1: Value chain – nuclear power



Source: BofA Merrill Lynch Global Research

Technology vendors

There are many nuclear power solutions in the world, including AP1000 solution of Toshiba - Westinghouse, EPR solution and APWR solution of Areva - Mistubishi, ABWR solution and ESBWR solution of GE - Hitachi, OPR1000 solution and APR1400 solution of KOPEC (Korea), CPR1000 solution and CNP1000 solution offered by the Chinese vendors, i.e. Guangdong Nuclear Group & China National Nuclear Corp.

In China, AP1000 (Toshiba - Westinghouse), APR1400 (KOPEC), and CPR1000 (Guangdong Nuclear Group) seem to be gaining shares. CPR1000 is a second generation (2G) technology. AP1000 & APR1400 are both 3G (safer than 2G).

Equipment vendors

Top equipment vendors include DHIC, Toshiba, Mistubishi, Hitachi, Areva, IHI, ENSA, Ansaldo, Dongfang Electric (China), Shanghai Electric (China), Harbin Power (China), Bharat. Dongfang Electric is currently the leading vendor in China, with a focus on 2G. Shanghai Electric has a good presence in 3G nuclear power technology and Harbin Power is catching up. For a detailed comparison among the leading power equipment vendors, please have a look at the in-depth report by our industrial analyst Edmond Huang Ride the tide, Sep 27.

Parts vendors

Major parts vendors include casting/forging of reactor vessel, steam generators, reactor internals, pumps, valves, air handling unit, digital instrumentation systems.

Forging seems to be the most profitable segment along the value chain as well as the bottleneck for the entire industry. Entry barrier is high. We often see them making 30% operating margins on nuclear equipments vs. around 5% for nuclear island vendors. Top player are JSW (Japan), DHIC (Korea), China First Heavy (Edmond Huang, An increasingly nuclear house, 27 September 2010), and potentially China Er Zhong (Edmond Huang, Growing greener, Sep 27).

Nuclear power plant operators

Unlike subsidy-dependent solar and wind farm operators, nuclear power plants can achieve reasonable returns on their own. Our channel check indicates that nuclear power plants can achieve mid teens ROE, making the sector a descent investment target. Unfortunately, there is no pure play in this segment.

Uranium miners

Uranium is the most important nuclear fuel. Top uranium resources countries include Australia, Canada, Kazakhstan, Nigerian, US, South Africa, Russia, Brazil, Namibia and China. For potential exposures, please refer to the research by our Australian colleagues, Geln Chipman and Peter O'Connor (Uranium: Fears on Resource Rent Tax look unfounded, 9 Sep 2010).

Related listed Chinese companies

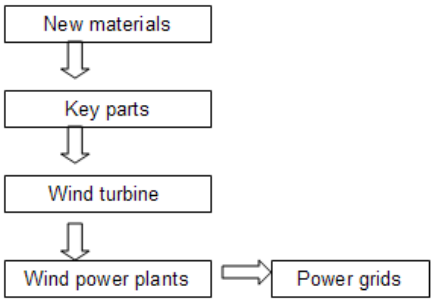
Table 5.6 contains a list of companies that have exposure to the nuclear industry in China. Among them, Harbin Power, Dongfang Elec, China First Heavy, Auto Electric Power, Shentong Valve, SUFA Tech, Orient Zircon, Shanghai Automation, Fangda Carbon New Material, Nanfeng Ventilator and Dun'An have meaningful exposure relative to the size of their businesses.

Table 5.6: Exposures to nuclear power

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
1133 HK	Harbin Power	2.2	Nuclear island	Medium	A power equipment vendor with footprints in new energy. Products cover thermal, hydro, nuclear (focus on 3G), and wind.
600875 CH /1072 HK	Dongfang Electric	9.3	Nuclear island	Medium	A power equipment vendor with good footprints in new energy. Produces cover thermal, hydro, nuclear (focus on 2G), and wind. In 2009, coal fire power equipments contributed to 63% of the total revenue, wind ~20%, hydropower ~9%, nuclear power ~6%. In terms of new orders received in 2009: thermal 46%, wind 15%, nuclear 26%, hydro 5%.
601727 CH /2727 HK	Shanghai Electric	14.7	Nuclear island	Low	A power equipment vendor, a large industrial conglomerate. Power produces cover thermal, hydro, nuclear (3G), and wind.
601106 CH	China First Heavy	6.0	Forging	Medium	The domestic leader and among the top 3 in the world.
601268 CH	China Erzhong	3.3	Forging, GW-grade half-speed nuclear turbine rotor	Low	GW-grade half-speed nuclear turbine rotor
002227 CH	Auto Electric Power	0.6	Power supply system	Medium	A power supply equipment vendor. Main product is high frequency switching DC power supply system, which contributed to ~80% of its 1H10 revenues. The company is the only qualified domestic power supply system vendor for nuclear power plants. Charging station for electric cars may potentially become a major earnings driver in the future. The company & BYD were both chosen to build charging stations in Shenzhen on a pilot test basis.
002438 CH	Shentong Valve	0.6	Valves for nuclear power	High	Nuclear related revenues reached 40% in 1H10. Valve usually accounts 1-2% of a nuclear power plant's capex.
000777 CH	SUFA Tech	1.0	Valves for nuclear power	Medium	The only listed arm of China Nuclear Group.
002167 CH	Orient Zirconic	1.0	Nuclear grade zirconium	High	Main product is high-purity zirconia with plans in nuclear grade zirconium.
600848 CH	Shanghai Automation	0.7	Automation system	Medium	A meter and automation system vendor, a member of Shanghai Electric Group. It owns a 49% stake in State Nuclear Power Automation System Co.
600550 CH	Tianwei Baobian	4.2	Transformers, solar, wind	Low	Transformer producer, 45% of domestic market share, the only qualified domestic transformer vendor for nuclear power plants. Also a supplier of solar power equipments and wind power equipments.
600516 CH	Fangda Carbon New Material	2.2	Nuclear grade graphite	Medium	Main product is graphite electrode with steel industry as its biggest customer. Graphite products represent 70% of the company's revenues, iron ore ~20%. Graphite is widely used in many industries. Nuclear grade graphite may become a growth driver.
300004 CH	Nanfeng Ventilator	0.7	Nuclear island cooling equipment	High	It specializes in nuclear HVAC technologies. It is the only domestic company that has gigawatt grade nuclear HVAC. Nuclear contributed to 56% of its 1H10 revenues. Its air handling systems are also used in subways and tunnels.
002011 CH	Dun'An Artificial Environment	1.4	Nuclear island cooling equipment	Medium	Air conditioning equipment vendor, also a vendor of nuclear HVAC system. Air conditioning equipments are used in nuclear power plants, subways, 3G base stations, and sewage source heat pump system. The company is building a Polysilicon plant with 30mn annual capacity, completion expected in 2H10. It has also set up a subsidiary to invest in solar power plants.
600456 CH	Baoji Titanium	1.9	Nuclear grade titanium pipes	Low	70%+ revenue derived from titanium products, which are used in industries like chemicals, construction, aviation, space, shipbuilding, and healthcare.
600328 CH	Lantai	0.7	Nuclear grade sodium	Low	The company has salt resources. It's also the world's largest sodium producer and the only domestic nuclear grade sodium vendor. Sodium serves as coolant in neutron reactors. 60% sodium is used to produce dyes, 30% for the pharmaceutical industry, ~5% for agriculture chemicals/nuclear/others.
002255 CH	Hailu Heavy Industry	0.9	Components for nuclear reactors	Low	Main product is exhaust heat boiler, which contributed to 73% of its 1H10 revenues. Nuclear contributed to 1.2% of its 1H10 revenues. Its nuclear equipments include cylinder basket (for reactor), and nuclear grade vessels.
600416 CH	Xiangtan Electric	1.4	Pumps	Low	The company is an AC electromotor and pump maker. Wind power equipment has become its largest business, contributed to 56% of its 1H10 revenue. The company also produces pumps for nuclear power plants.
600268 CH	Guodian Nanjing Automation	1.1	Auxiliary products	Low	A power automation equipment vendor. Main products include power grid protection and automation, power plant protection and automation, industrial automation and hydropower automation. The company set up a new energy subsidiary with main products being wind power control system, solar power inverter boosters, nuclear power auxiliary products, frequency converters and vacuum cleaner. The company has a 30% stake in a desulfurization (activated carbon) company.
600202 CH	Harbin Air Conditioning	0.7	Air handling unit	Low	An industrial air cooler maker. 2009 revenue breakdown: 54% for power plants, 21% for chemical industry. The company also makes air handling unit for nuclear power plants.
600558 CH	Atlantic China Welding	0.4	Welding materials	Low	A welding material vendor with customers including the nuclear power industry.
600642 CH	Shenergy	3.7	Operator	Low	Main business is IPP, oil and gas. Has stakes in nuclear power plants.
000543 CH	Anhui Wenergy	0.8	Operator	Low	IPP. Signed agreement to invest in a nuclear power plant.

Source: BofA Merrill Lynch Global Research

Chart 5.2: Value chain – wind power



Source: BofA Merrill Lynch Global Research

Wind power

Wind power is one of the most promising new energy sources in long term, despite short term challenges (power grid bottleneck). China surpassed the US to become the world's largest wind turbine market in 2009. But growth has slowed down in 2010, as power grid became a bottleneck. As debottlenecking takes time, the government is developing offshore wind resources along the coast where grid infrastructure is well established. This should boost demand for larger and direct-drive turbines. Wind power turbine is a highly competitive market with a low barrier of entry. We favor attractively valued wind equipment stocks such as China Mingyang Power over China High-speed and Goldwind.

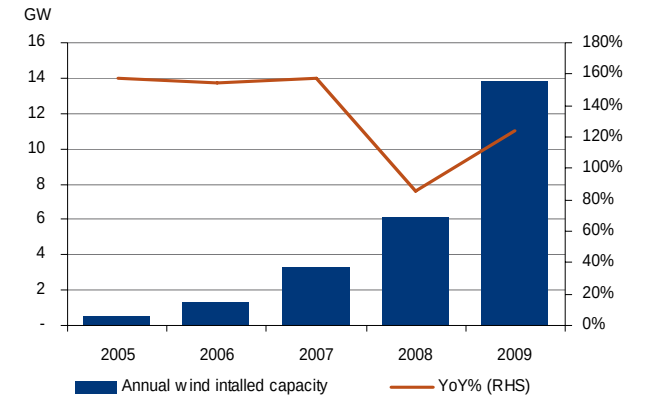
Power grid: a bottleneck

Wind turbine demand grew by a CAGR of more than 100% during 2007-2009, but had slowed down quickly to about 12% in 2010 partly due to high base effect and partly due to grid bottleneck. The newly installed capacity amounted to 15-16GW in 2010 (vs. 13.8GW in 2009), according to China High Speed and China WindPower's estimates.

Wind power, grid connection is an issue.

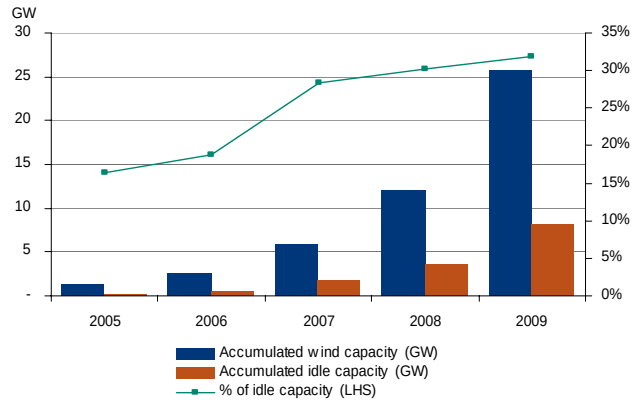
Wind turbine capacity installation is far quicker than grid network construction. By 2009, as much as 8.2GW (or 31.8% of cumulative installed capacity) remained idle according to China Wind Energy Association (Chart 5.3 & 5.4).

Chart 5.3: Wind turbine demand in China (GW)



Source: China Wind Energy Association

Chart 5.4: Idle wind capacity (GW)



Source: China Wind Energy Association, China Electricity Council, BofA Merrill Lynch Global Research estimates

NDRC plans to expand investment in grid - under the 12th Five-Year Plan, capex may reach Rmb370-390bn per annum, up from Rmb330bn in 2010, with a focus on ultra-high voltage (UHV) equipment, transmission lines and smart-grid investment (Angello Chan, "China may spend up to Rmb9tn for grid, new energy projects", 30 August 2010). At this stage, it's unclear whether this will add enough connectivity for wind. The Chinese government targets a wind capacity of 150GW by 2020, implying a 17% CAGR, or an average 11.3GW of additional installment a year. This suggests over capacity in the wind turbine manufacturing sector unless the government revises up its target significantly.

This forces the industry to go offshore …

Go offshore

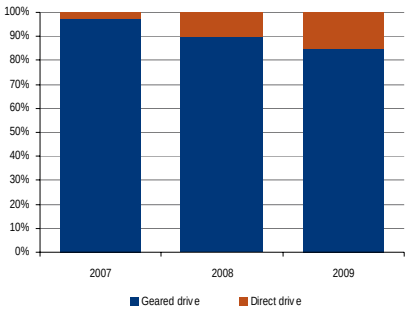
Grid congestion may continue in Inner Mongolia and North East China over the next few years. As a result, “Go offshore” will likely be the investment theme for wind power in 2011/12 because coastal areas are well grid-connected and have abundant wind resources. More importantly, offshore wind farms are much closer to major power consumption regions so long distance grids are not required.

The first offshore wind turbine generator (WTG) prototype in Asia was installed by Goldwind (1.5MW direct-drive) in 2007 in Bohai Bay for CNOOC. Since 2009, China has started to accelerate the development for offshore wind energy. The first project is Shanghai Dongda Bridge with capacity of 100MW, using 3MW wind turbines supplied by Sinovel and Shanghai Electric. Jiangsu Rudong is also developing an offshore wind farm. Four more offshore projects (Binhai, Sheyang, Dafeng, and Dontai in Jiangsu) are being tendered, with installed capacity of 200-300MW each. Jiangsu has wind resources of 18GW available for wind farm development, according to the China Renewable Energy Development Committee.

Direct-drive gaining market share

Although double-fed is a more mature technology with ~85% global market share, direct-drive is gaining traction in recent years (Chart 5.5). Some traditional double-fed wind turbine makers are getting into direct-drive, e.g. Dongfang Electric.

Chart 5.5: % of direct drive in China



Source: Company, China Wind Energy Association, BofA Merrill Lynch Global Research estimates

Compared to double-fed, direct-drive has fewer easily breakable parts, thus enjoy higher availability rate; it has fewer parts and is less complicated in terms of maintenance, thus less operating costs and energy loss via friction; it is also grid-connection friendly (less breakdown, more stable power supply). As a result, most offshore wind farm operators prefer direct-drive.

Major Chinese manufacturers are going direct (Table 5.7). Goldwind, the second-largest turbine maker in China (19.7% market share in 2009) and the fifth-largest in the world, is stopping the production of geared 750kW units and will adopt direct-drive technology for all 1.5MW+ units (except for 3.0MW hybrid drive). It current has about 4GW of direct-drive manufacturing capacity. XEMC might have doubled its deliveries of direct-drive units from 454MW in 2009 to some 1GW in 2010. It currently has about 3GW of direct-drive capacity. Elsewhere, Dongfang Electric has completed its 1.5MW direct-drive prototype in its Hangzhou plant (525-750MW per year capacity) and Harbin Power has just announced its plan to produce direct-drive with GE. China Energine provides only direct-drive wind turbines, but its scale is relatively small (760MW) at this stage.

Table 5.7: Installed capacity of direct-drive wind turbine in China (MW)

	2006	2007	2008	2009
Goldwind	-	86	519	1,592
XEMC	-	8	120	454
Dongfang Electric	-	-	-	-
Harbin Power	-	-	-	-
China Energine	-	-	-	50
Total (MW)	-	94	639	2,095
Market share	-	2.8%	10.2%	15.2%

Source: Companies, China Wind Energy Association

… which is good for direct-drive.

The rising market share of direct drive is a threat to gear box makers, i.e. China high speed (Laurent Wong, Gone with the wind, 27 Sep), as the technology does not use gear box. Gear box sector itself faces over capacity concerns, adding pressure to ASP. On the other hand, domestic direct drive wind turbine makers all use permanent magnetic materials which benefits related materials suppliers, including rare earth miners (more on this in the "New Materials" section).

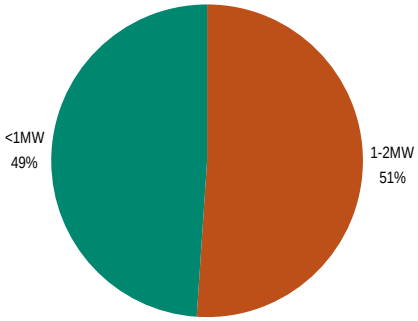
Turbine unit capacity is getting bigger

Turbine is getting more efficient.

The average size of wind turbines installed in China increased to 1.36MW in 2009 from 1.05MW in 2007.

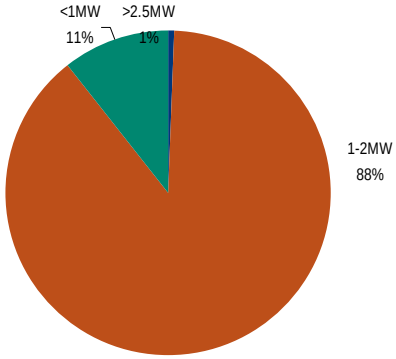
Currently, 1.5MW unit is the mainstream product, and 1-2MW units accounted for 88% of total demand in 2009 (Chart 5.6 & 5.7). Profitability is more complicated. Since the 1.5MW market is crowded, 750kW actually offered better margins: Goldwind's gross margin was 32.8% for 750kW units but 24.1% for 1.5MW in 2009. Goldwind's ASP for its 750kW units rose during 2007-1H2009, bucking the overall market trend.

Chart 5.6: Annual wind turbine demand by size in 2007



Source: China Wind Energy Association

Chart 5.7: Annual wind turbine demand by size in 2009



Source: China Wind Energy Association

Favorable tariffs

The government is willing to give favorable tariffs.

A new pricing regime for **on-shore** wind farms became effective on Aug 1, 2009.

Wind power feed-in tariffs were set at Rmb0.51-0.61/Kwh across the country, some 40-60% higher than coal-fired tariffs (Table 5.8). NDRC divided the country into 4 categories (excluding off-shore) and set a standard wind power tariff for each. The new mechanism does not apply to existing wind farms whose on-grid tariffs were approved before Aug 1, 2009.

Table 5.8: Wind power tariffs

Region	Rmb/Kwh	Areas
Region I	0.51	- Inner Mongolia (excl. Chifeng, Tongliao, Xiang'an, Hulunbeier) - Xinjiang (incl. Urumqi, Yili, Changji, Kelamayi, Shihezi)
Region II	0.54	- Hebei (incl. Zhangjiakou & Chengde) - Inner Mongolia (incl. Chifeng, Tongliao, Xiang'an, Hulunbeier) - Gansu (incl. Zhangye, Jaiyuguan, Jiuquan)
Region III	0.58	- Jilin (incl. Baicheng, Songyuan) - Heilongjiang (incl. Jixi, Shuangyashan, Qitaihe, Suihua, Yichun, Daxinganling) - Gansu (excl. Zhangye, Jaiyuguan, Jiuquan) - Xinjiang (excl. Urumqi, Yili, Changji, Kelamayi, Shihezi) - Ningxia
Region IV	0.61	- All other regions

Source: NDRC, BofA Merrill Lynch Global Research

Offshore wind farm development is still in a preliminary stage. The current offshore tariff is set by a tendering process from wind farm investors. A reasonable offshore wind tariff is Rmb0.80/kW, according to Longyuan.

According to Daily Economic News (Sept 10, 2010), the results of the 1st round of offshore wind power tendering have come out with all four winning bidders being SOEs (Datang New Energy, China Power Investment, Shandong Nuneng, and Longyuan Power). The winning tariffs appear quite low – Binhai project, Rmb0.737/Kwh; Seyang, Rmb0.7047/Kwh; Dafeng, Rmb0.6396/Kwh; Dongtai, Rmb0.6235/Kwh. Mr. Shi Pengfei, deputy head of China Wind Power Energy Association, said the prices were too low and "have a lot of room for upward revision", as per Kwh investment for offshore wind power is ~50% higher than that of onshore. Interestingly, the winners were not the ones that offered the lowest prices, perhaps because the government doubted the credibility of some of the bids.

Key players along the value chain

Overall, it appears to us that investment opportunities in wind power, including turbine and parts makers and farm operators, are few because of overcapacity, competition and low return concerns.

Wind turbines

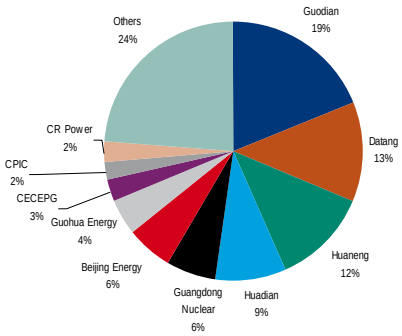
Goldwind (002202 CH) and Ming Yang (MY US) are the pure plays. Dongfang Electric is a major player, but wind turbine only contributed to 20% of its 1H2010 revenue given its scale in thermal power and nuclear power. Longyuan (916 HK), a wind farm operator, owns a 30% stake in a large wind turbine vendor.

Table 5.9: Exposures to wind turbine

Name	Country	Sales (MW) 2009	Market share	Ticker	Ticker/ description
Total		13,800	100%		
Sinovel	China	3,495	25.3%		A sister company of Huarui Casting (002204 CH).
Goldwind	China	2,722	19.7%	2208 HK/002202 CH	The largest listed wind power player. Mainly direct drive.
Dongfang Electric	China	2,035	14.8%	600875 CH/1072 HK	A power equipment vendor with good footprints in new energy. It makes power equipments for thermal, hydro, nuclear (focus on 2G), and wind. In 2009, coal-fired power equipments contributed to 63% of the total revenue, wind ~20%, hydropower ~9%, nuclear power ~6%. In terms of new orders received in 2009: thermal 46%, wind 15%, nuclear 26%, hydro 5%.
Guodian United power	China	768	5.6%	916 HK	A subsidiary of Guodian Group, which is one of China's largest IPPs. HK listed Longyuan Power has a 30% stake in the company with the remaining 70% held by Guodian Kehuan. Guodian Kehuan is the environmental arm of Guodian Group. Guodian Kehuan has another listed subsidiary, Longyuan Power Tech (300105 CH), which is a leading vendor of ignition devices for thermal power equipments.
Ming Yang	China	748	5.4%	MY US	One of the largest double-fed wind turbine makers.
Vestas	Foreign	609	4.4%		
Xiangtan Electric (XEMC)	China	454	3.3%	600416 CH	An AC electromotor and pump maker. Wind power equipment has become its largest business and contributed to 56% of its 1H10 revenue. The company also makes pumps for nuclear power plants.
GE	Foreign	323	2.3%		
Suzlon	Foreign	293	2.1%		
Gamesa	Foreign		< 2%		
Shanghai Electric	China		< 2%	601727 CH/2727 HK	A power equipment vendor, a large industrial conglomerate. It makes power equipments for thermal, hydro, nuclear, and wind.
Windey	China		< 2%		
Repower	Foreign		< 2%		
China Creative	China		< 2%		
Beizhong	China		< 2%		
Yuanjing	China		< 2%		
Southern Locomotive Times	China		< 2%	600458 CH	
Huayi	China		< 2%	600290 CH	1H10 revenue breakdown: electric transmission and transformation equipment 46%, wind power equipment 52%.
Nordex	Foreign		< 2%		
Yin Xing	China		< 2%	000862 CH	An automation instrument vendor, but wind power equipment has overtaken traditional business as its biggest revenue source. The company also operates wind farms, and has a growing presence in solar power equipment.

Source: CWEA, BofA Merrill Lynch Global Research

Chart 5.8: Top 10 wind farm operators 2009



Source: China Wind Energy Association

Parts

The key parts for wind turbines include blade, gear box & bearing, generator & electrical (generator, transformer, converters, controller and etc.). China High Speed (658 HK) is a leading gear box maker.

Wind farm operators

As a result of fierce competition, returns of the wind farms tend to be low. Many private enterprises have been squeezed out of the market for that reason. Currently most of the winning bidders are traditional IPPs, especially the large state owned IPP groups. The top five SOE IPPs account for over half of the installed capacity. Longyuan, associated with Guodian Group, is currently the largest wind farm investor in China.

Cautious on utilization hours

Weather plays an important role in utilization hours of wind farms. According to our utilities analyst Angelo Chan, expectations of higher utilization rate for wind power may not be met due to offtake curtailment by the grid. Many wind farms are built in North China, which is bless with good wind resources but faces -40C temperature. Priority to supply heat from cogen power units overrides the grid dispatching order to by wind power. With a lack of transmission capacity to other provinces, wind farm utilization hours can potentially disappoint during the cold winter.

For 2011, listed wind farm and wind equipment suppliers are guiding higher grid interconnection capacity by 20-40% than unlisted PRC agencies. We believe stocks, even for well-managed companies, trading at premium valuation levels could see downside pressure if these high-expectation targets are not met.

To help resolve the grid interconnection issue, the PRC government will soon be releasing new standards to allow grid operators better communicate, to predict and control wind farm output in order to protect the overall grid stability and reliability. This may require better wind turbine equipment components so that turbines do not disconnect during periods of low wind. Managing or storing wind output is also becoming increasingly important as wind capacity mounts since wind output is often produced at night during periods of low demand, so counter-peak generation nature for wind output also needs to be managed in order to maintain wind farm utilization hours at current levels.

Expectations of high utilization hours may also not be met due to equipment problems. NDRC has completed investigation into faulty wind turbine (fire, blades cutting into tower causing turbine collapse, turbine does not produce power etc) problems and the results may be released soon. We believe several turbine manufacturers will be found to have suffered quality problems and the NDRC may conduct annual turbine quality tests going forward. Higher-than-expected maintenance costs and lower-than-expected output/utilization hours as a result of turbine quality problems could lead to potential earnings disappointment.

Table 5.10 lists listed Chinese companies with meaningful exposure to wind power value chain except those listed in Table 5.9 which have large exposure to the wind turbine market.

Table 5.10: Exposures to wind power

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
658 HK	China High Speed	2.4	Transmission equipment for wind power	High	The largest wind turbine gearbox manufacturer in China with about 55% market share in 2009. It supplies wind gearboxes to major wind turbine manufacturers such as Sinovel, Goldwind, GE, and Vestas. Its wind gear products range from 750kW to 3MW, with 1.5MW being the most common one. It also manufactures other types of gears including those for marine, construction, general purpose, high-speed and rolling gearboxes.
916 HK	Longyuan	6.8	Wind farm, wind turbines	High	The renewable energy arm of China Guodian Group (one of China's largest state owned IPP groups). It is the largest wind farm company in Asia. The company also has ambitions in solar power. The company has a stake in Guodian United, a leading wind turbine vendor in China.
735 HK	China Power New Energy	0.7	Wind farm	High	The renewable energy arm of China Power New Energy. Wind power is its most important business. Other businesses include: hydro-power, biomass power, garbage power and environmental protection-related projects.
182 HK	China WindPower	0.7	Wind farm	High	Wind farm operator and wind power engineering company.
CNW CN	China Wind	0.1	Wind farm	High	It holds the exclusive rights for wind energy development in Du Mon County (Heilongjiang).
CWS US	China Wind Systems	0.1	Forged components	High	It manufactures precision forged components for the wind power industry. The Company also makes precision forged components and industrial machines for other industries.
APWR US	A-Power Energy	0.2	Turbines	High	Provider of distributed power generation ("DG") systems and a fast-growing manufacturer of wind turbines. It has wind turbine manufacturing facilities in China, and reached an agreement to establish a partnership with W2E (Wind To Energy) GmbH to produce wind turbine gearboxes in Shenyang. It also acquired Evatech, a designer and manufacturer of industrial equipment for amorphous-silicon (a-Si) photovoltaic (PV) panels, in 2010.
NWIG LN	Northwest Inv	0.0	Hydro, wind, biomass	High	Focuses on clean energy projects, including hydropower, wind power, biomass energy and Liquefied Natural Gas power.
REAG SP	Renewable Energy Asia	0.1	Wind farm, wind turbines	High	A vertically integrated renewable energy company. Main businesses are wind farm, wind turbine manufacturing, and wind farm engineering.
600089 CH	TBEA	5.9	Wind turbines	Medium	A power grid equipment vendor (transformers, cables), with a growing solar presence. 1H10 revenue breakup: transformers 58%, cables 19%, solar 14%. The company also has a stake in Goldwind.
600112 CH	Changzheng Electric	0.7	Wind turbines	Low	An electrical products producer (electrical components, relay protection, and full electrical equipments). It also makes auto parts (connecting rods). 2009 revenue breakdown: electrical products 90%, auto parts 6%. The company is getting into wind power equipment business and its products are most suited for off-shore wind farms.
600192 CH	Greatwall Electrcal	0.5	Parts	Low	Current main business: electrical products, including high voltage switchgears, contactors and circuit breakers. A pending restructuring may get the company into the wind power business.
000836 CH	Xinmao Science & Tech	0.4	Parts: blade	Low	Mainly an optical communication products producer. Property is its second largest business. Wind turbine blade only contributed to ~3% of its 1H10 revenues.
002009 CH	Jiangsu Miracle	0.5	Parts: blade	Medium	An automation system (e.g. assembly lines) contractor and manufacturer. Clients include auto makers and logistics companies. It also makes wind turbine blades from bamboo; the business is at an early stage. Wind turbine blade contributed to ~16% of its 1H10 revenues.
600550 CH	Tianwei Baobian	4.2	Transformers, solar, wind	Low	A transformer producer with a 45% domestic market share; the only qualified domestic transformer vendor for nuclear power plants. Also a supplier of solar power equipments and wind power equipments.
002080 CH	Sinoma Sci&Tech	1.0	Parts: blade	High	A maker of special fiber composite products, including wind turbine blades and high temperature filter materials.
600458 CH	Times New Material	1.9	Parts: blade	Medium	A new materials vendor. Its main product is polymer elastic component, which reduces vibration and noise. The product is widely used in railcars, wind power equipments and auto. The company is ambitious in wind power equipment, targeting to be a top three blade vendor in China.
300004 CH	Nanfeng Vent	0.7	Parts: blade	Low	Mainly a nuclear equipment vendor, has presence in wind power (less than 3% of its 1H10 revenue)
002147 CH	Fangyuan	0.6	Parts: bearing	Medium	A slewing bearing vendor; products are used in infrastructure machines, wind and solar equipment.
002122 CH	Tianma Bearing	2.5	Parts: bearing	Medium	Main products: bearings and machine tools. Wind power equipment contributed to ~20% of its 1H10 revenues.
002201 CH	Jiuding New Material	0.3	Parts: cabin cover, blade	High	A glass fiber producer with a growing presence in wind power, e.g. cabin cover and blade. The company currently makes blades using glass fiber; it is also doing research to use multiaxial fabric.
000415 CH	Xinjiang Huitong	0.5	Metal parts	Medium	It makes metal parts for wind power equipment. Currently main business:water conservancy projects construction.
002184 CH	Hi-Tech Control	0.5	Converter	Medium	It specializes in industrial automation (system integration).
002204 CH	Huarui Casting	0.8	Heavy casting	Medium	A heavy metal casting company with the largest market share in power equipment. 60% of its 2009 revenue came from the power industry. Wind power contributed to 27% of its 2009 revenue, up 422% YoY; while thermal power and hydro power's declined. The company also does metal casting for a wide range of machineries. The company's parentco is the largest wind turbine vendor in China.
002272 CH	Sichuan CRUN	0.5	Lubrication system	Medium	A hydraulic lubrication system maker (67% of its 2009 revenues). Exhaust heat boiler is another growth driver, with ~26% revenue contribution. The company is a close partner of Dongfang Boiler (subsidiary of Dongfang Electric), and is capable of making parts for 1GW ultra supper critical boilers. The company's lubrication system is mainly for the cement industry and wind power industry.

Table 5.10: Exposures to wind power

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
600268 CH	Guodian Nanjing Automation	1.1	Control system	Low	A power automation equipment vendor. Main products include power grid protection and automation, power plant protection and automation, industrial automation and hydropower automation. It has set up a new energy subsidiary with main products being wind power control system, solar power inverter boosters, nuclear power auxiliary products, frequency converters and vacuum cleaner. The company also has a 30% stake in a desulfurization (activated carbon) company.

Source: BofA Merrill Lynch Global Research

Solar power

Solar power remains largely a Europe-centric market.

Solar power remains largely a Europe-centric market. Europe had ~70% of the world's total installed solar capacity as at the end of 2009. China is by far the world's largest solar power equipment maker, but the industry almost completely relies on exports (Table 5.11). Given a low entry barrier and capacity concerns, we are cautious about the industry's outlook.

Table 5.11: China's solar industry vs. the world

	2003	2004	2005	2006	2007	2008	2009
China production (MW)	12	50	143	438	1088	2000	4000
Growth	100%	317%	186%	206%	148%	84%	100%
Global production (MW)	744	1200	1760	2560	4000	6400	10000
Growth	33%	61%	47%	45%	56%	60%	56%
As % of global production	1.6%	4.2%	8.1%	17.1%	27.2%	31.3%	40.0%
As % of global installation	0.50%	0.30%	0.30%	0.57%	0.71%	0.71%	N.A.

Source: Chinese Academy of Science, BofA Merrill Lynch Global Research

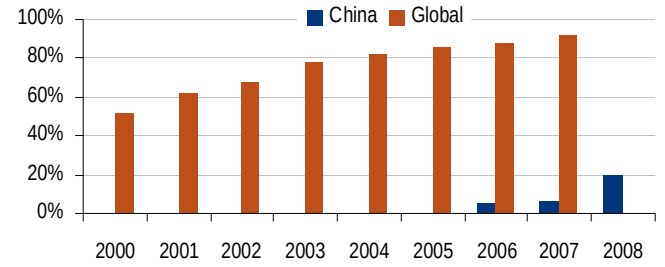
Overall, we believe cost of solar power is too high relative to other new energy sources, limiting the industry's upside. The industry itself is very energy intensive, especially poly silicon production. According to calculations of Chinese Academy of Science, the energy pay-back period (time for solar cell to produce as much power as what is used to produce the cell) can be above 4 years in some regions in China. Even in Lasha, a sunlight rich city, the pay-back period is still almost 2 years. It seems to us that we will need some technology breakthroughs to make solar power more cost competitive.

China: Lagging behind in installation

China is lagging behind in installation.

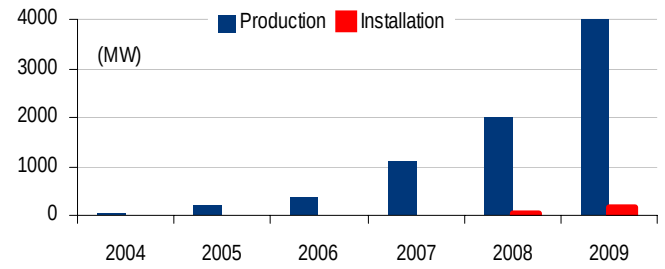
China's installation of solar power has lagged far behind its solar equipment production. China's total solar power installation was 160MW in 2009, quadrupled that of 2008; but this was a mere 4% of its solar power equipment production (Chart 5.10).

Chart 5.9: Percentage of solar capacity that is on-grid



Source: Chinese Academy of Science, BofA Merrill Lynch Global Research

Chart 5.10: China solar power equipment production vs. installation



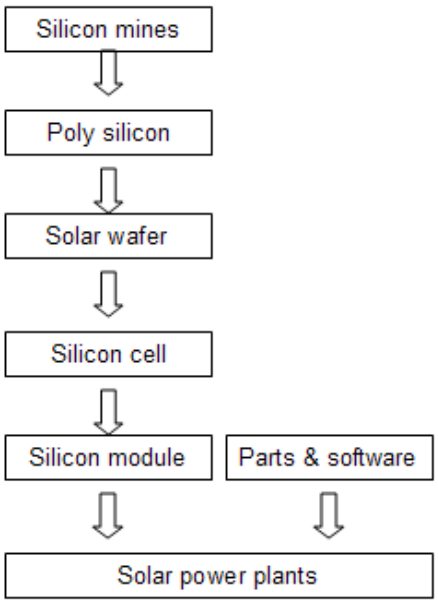
Source: Chinese Academy of Science, BofA Merrill Lynch Global Research

In addition, unlike the developed markets, where ~90% of the solar power is sold to power grid, China's connection ratio is very low, merely 20% by the end of 2008 (Chart 5.9). Currently, most domestic solar power application is for the telecoms industry and in remote areas not reached by grid. The connection rate is expected to rise as more utility scale solar farms are being developed. Like wind power, power grid may potentially become a bottleneck for the industry. In addition, the high cost of solar power generation (in the absence of a major cost/technology breakthrough) and the lack of a government benchmark tariff subsidy may also limit the near term adoption of solar power in China.

Global demand outlook: uncertain

Many European countries have already reduced their solar tariff subsidies after the global financial crisis. In addition, the risk of trade friction is particularly high for Chinese solar manufacturers. China's solar module capacity is ~40% of the world total, but its domestic solar market is only ~1% of the world's total. On Oct 15, 2010, the US launched an anti-dumping investigation on Chinese new energy industry under Section 301 of US Trade Act of 1974.

Chart 5.11: Value chain – solar power



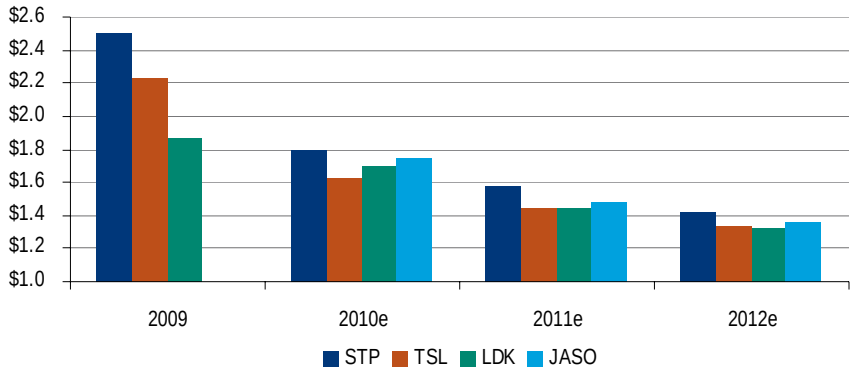
Source: BofA Merrill Lynch Global Research

Key players along the value chain (Chart 5.11)

Upstream is ingot and wafer; downstream is solar cell and module. Most Chinese companies focus on the downstream with some, vertically integrated.

Given the uncertain demand outlook, low cost structure is the key in our opinion, (Chart 5.12), e.g. Trina Solar (Timothy Bush, China solar investment framework; reinstate coverage, 27 Sep 2010). On a relative basis, we prefer Chinese companies due to their cost advantage over US and European peers.

Chart 5.12: All-in module cost comparison ($/watt)



Source: Company data, BofA Merrill Lynch Global Research Estimates

Table 5.12 lists Chinese listed companies with meaningful exposure to the solar sector.

Table 5.12: Exposures to solar industry

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
155 HK	China Solar Energy	0.1	c-Si cells, modules	High	Thin film photovoltaic cells, panels, and modules.
SOLR US	GT Solar	1.4	Silicon furnace & reactors	High	An American company with over 60% revenue coming from China. It makes reactors to make poly-silicon and furnaces to make solar ingots/wafers. With the acquisition of Crystal Systems, the company now also makes equipment for sapphire substrate (for LED).
397 HK	China Gogreen	0.2	c-Si cells, modules	High	Solar cells and modules.
566 HK	Apollo Solar	0.5	c-Si modules	High	Equipment and end-to-end manufacturing lines for the mass production of thin film silicon solar modules.
916 HK	Longyuan Power	6.8	Solar farm	Low	The renewable energy arm of China Guodian Group, one of China's largest state owned IPP groups. It is the largest wind farm company in Asia. The company also has ambitions in solar power.
712 HK	Shanghai Comtec Solar	0.4	Ingots and wafers	High	Solar grade silicon ingots and wafers.
750 HK	China Singyes Solar	0.4	Solar powered products	High	It manufactures glass and stone curtain walls and solar energy products, including solar powered bus shelters, solar powered street lighting, solar powered pumping systems, and other products.
3800 HK	GCL Poly Energy	5.7	Poly-silicon	High	It makes solar grade poly-silicon, solar wafers and operates cogeneration plants and in China.
STP US	Suntech Power	1.5	c-Si cells, modules	High	The world's largest solar module supplier with 1.4GW capacity as of 2Q10.
CSUN US	China Sunergy	0.2	c-Si cells, modules	High	A China-based solar cell producer.
JKS US	JinkoSolar	0.5	Wafers, c-Si cells and modules	High	Solar wafers, cells and modules.
SOL US	ReneSola	0.8	Silicon wafers	High	Solar wafers, expanding into modules and poly-silicon. 3,000MT poly-silicon capacity and 1.2GW wafer capacity as of 2Q10.
SOLF US	Solarfun Power	0.6	c-Si cells, modules	High	Solar cells, modules.
JASO US	JA Solar	1.2	Modules, wafers	High	Solar cell manufacturer. Capacity as of 2Q10: 1.2GW cells, 120MW wafers, and 300MW modules

Table 5.12: Exposures to solar industry

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
					OEM.
TSL US	Trina Solar	1.9	Integrated	High	A vertically integrated PV module producer. By 2Q10, 700MW ingot/wafer capacity and 850MW cell/module capacity.
YGE US	Yingli Green Energy	1.6	Integrated	High	A fully integrated PV module producer with in-house poly-silicon capacity.
LDK US	LDK Solar	1.4	Silicon wafers	High	The world's largest silicon wafer supplier. LDK also has 13,000MT poly-silicon capacity being ramped up.
JHL LN	Jetion Solar	0.1	c-Si cells, modules	High	Solar cells and modules.
CTDC US	China Technology Dev	0.0	Base plates, solar lamps	High	It makes base plates of thin film solar cells, solar illuminating lamps for lawns and gardens, solar power packs for battery recharging, solar street lights, and solar decorating products.
CSIQ US	Canadian Solar	0.6	Wafers, c-Si modules	High	A crystalline silicon PV module supplier.
UMS SP	Unionmet Singapore	0.0	Indium ingots	Low	It makes indium ingots and their by-products such as zinc ingots, sheets, carbonate, sulphates and rotary kiln powder. Indium Ingots are a raw material used for flat panel displays and solar energy batteries.
600184 CH	New Huaguang	1.4	Solar cells, optical glass, missile technology	High	The company is an optical products vendor, but solar has become a major revenue source. The company has a pending M&A to acquire some defense assets (precisely guided weapon system) from its parentco, which is a leading optical company in China's defense industry.
600151 CH	Aerospace Automobile	2.0	Solar cell, silicon	High	Solar products contributed to 54% of 1H10 revenue, auto parts 33%, new materials 7%. The company was the first listed arm of China's space industry. Products include solar equipment, silicon, auto air conditioners, auto electronics.
600089 CH	TBEA	5.9	PV modules	Medium	A power grid equipment vendor (transformers, cables), with growing solar presence. 1H10 revenue breakup: transformers 58%, cables 19%, solar 14%. The company also has a stake in the largest domestic wind power equipment maker Goldenwind.
002083 CH	Sunvim	1.5	c-Si cells	Low	Mainly a textile company: towel, home textile. Investing in solar power.
002218 CH	Topraysolar	1.1	c-Si cells, modules	High	A solar module supplier. Also has some presence in LED downstream products (lamps, display).
600703 CH	Sanan Optoelectronics	4.1	Modules, mills	Low	A vendor of LED wafer and chips, has some presence in solar power.
600550 CH	Tianwei Baobian	4.2	Transformers, solar, wind	Low	A transformer producer, 45% of domestic market share, the only qualified domestic transformer vendor for nuclear power plants. Also a supplier of solar power equipments and wind power equipments.
600885 CH	Linuo Solar	0.2	Solar water heater	High	Solar water heater.
002147 CH	Fangyuan Slewing Ring	0.6	Parts: slewing bearing	Medium	A slewing bearing producer with products being used in infrastructure machines, wind power equipment and solar equipment. Each wind power unit needs 4 sets of bearings. "Sun chasing" solar equipment also needs bearings.
600770 CH	Jiangsu Zongyi	2.2	c-Si cells	High	A conglomerate, heavily investing in solar industry. The company was traditionally a tech company, specializing in smart card and software. 1H10 revenue breakdown: solar 50%, smart card 19%, software 17%. It has a controlling stake in a JV with Tsinghua University specializing in superconducting technology.
000533 CH	Guangdong Macro	1.1	HCPV	Low	Power grid equipment and home appliances. Main products are transformers and gas hot water heater. It acquired a stake in a small solar equipment company to enter the new energy industry.
000862 CH	Yin Xing Energy	0.5	c-Si cells	Low	A automation instrument vendor, but wind power equipment has become its biggest revenue source. The company also operates wind farms, and has a growing presence in solar power equipment.
002056 CH	Hengdian Magnetics	2.5	c-Si cells	Low	A magnetic materials vendor. Main products are soft ferrite materials and permanent ferrite magnet. Announced to get into the solar business last year.
600482 CH	Fengfan	1.1	c-Si cells	Low	A battery maker. Main product is lead-acid storage battery (for auto), which contributed to ~90% of its 1H10 revenue. The company is expanding into lithium battery. Currently its products are mainly for digital camera and lap tops and its electric car lithium-ion battery is still at the research stage. The company also produces solar cells (again at an early stage). The company owns a gold mine, with estimated total reserves of gold 10.2 tons, silver 1550tons, zinc and lead 870,000 tons.
600268 CH	Guodian Nanjing Automation	1.1	Inverter boosters	Low	A power automation equipment vendor. Main products include power grid protection and automation, power plant protection and automation, industrial automation, and hydropower automation. The company has a new energy subsidiary, whose main products are wind power control system, solar power inverter boosters, nuclear power auxiliary products, frequency converters and vacuum cleaner. The company also has a 30% in a desulfuration (activated carbon) company.
300029 CH	Tianlong Photoelectric	1.0	Silicon furnace & cutting machines	High	A silicon equipment vendor. Its main products are single crystal furnace (crystal growers), and cutting machines.
300080 CH	Xindaxin Materials	1.2	Wafer cutting edge materials	High	A silicon equipment vendor. Its main products are silicon wafer cutting edge materials, a consumable of the solar industry.
002006 CH	Jinggong Science & Tech	0.9	Silicon ingot furnace, Poly-silicon	Medium	An equipment vendor; traditional products include textile machines, and construction material equipments. Solar related revenues jumped to 34% in 1H10 (silicon ingot furnace, poly-silicon processing). The company has 14 patents in silicon ingot furnace.

Table 5.12: Exposures to solar industry

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
600206 CH	Grinm Semiconductor	0.5	Wafers, ingots	High	A silicon material vendor. Major products are polished silicon wafers, including 4-6 inches, eight inches and 12 inches polished silicon wafers. In downstream, home appliance was the main earnings driver in 2009, but solar was the big swing factor.
002129 CH	Zhonghuan Semiconductor	1.8	Wafers, ingots	High	A silicon material vendor.
000012 CH	CSG	5.5	Poly-silicon, solar cells, wafer cutting, solar glass	Medium	The company is a plane glass maker. Solar segment is growing fast, contributing to 25% of its 1H10 revenues.
600644 CH	Leshan Electric Power	0.7	Poly-silicon	Medium	A utilities conglomerate with major presence in the silicon industry. Hydro power, tap water, and gas are the main revenue sources. Has a 51:49 silicon JV with TianWei Biaobian. Silicon business is growing fast, and may potentially become the main earnings driver.
600131 CH	Minjiang Hydropower	0.6	Poly-silicon	Medium	A hydro power company with increasing solar presence. The Tianwei JV makes Poly-silicon. Huaguan, another associate company, makes 3rd generation solar water heaters and solar power equipments.
600550 CH	Tianwei Baobian	4.2	Poly-silicon	Low	A transformer producer, 45% domestic market share, the only qualified domestic transformer vendor for nuclear power plants. Also a supplier of solar power equipments and wind power equipments. Has a 49:51 silicon JV with Leshan Electric Power.
600674 CH	Chuantou Energy	2.1	Poly-silicon	Medium	An IPP, with a major stake in a big silicon producer (Xinguang Silicon). The company has a pending asset injection (announcement made in Dec 2008), Ertan Hydro Power, which is one of China's largest hydro power companies.
600220 CH	Jiangsu Sunshine	1.5	Poly-silicon	Medium	Mainly a textile and garments company, invested Rmb1.6bn in a Poly-silicon JV in 2007.
600151 CH	Aerospace Automobile	2.0	Poly-silicon, solar cells	High	It's evolving from an auto parts (auto air conditioners, and auto electronics) company to a solar company.
002011 CH	Dun'An Artificial Environment	1.4	Poly-silicon, solar farm	Medium	An air conditioning equipment vendor, also a vendor of nuclear HVAC system. Air conditioning equipments are used in nuclear power plants, subways, 3G base stations, and sewage source heat pump system. The company is building a Pol-ysilicon plant with 30mn annual capacity, completion expected in 2H10. It has also set up a subsidiary to invest in solar power plants.
600438 CH	Tongwei	1.0	Poly-silicon	Low	An aquatic/animal feed producer. The world's largest aquatic feed producer. Recently invested in silicon Poly-silicon production.
600884 CH	Ningbo Shanshan	1.5	Single crystal silicon	Low	A lithium-ion battery materials vendor, with 36% of its revenue coming from such products. It's has a domestic garment brand, with 62% of its revenue coming from the segment. The company has a 20% stake in an associate company which makes single crystal silicon films from scraps.
600629 CH	Lengguang Industrial	0.6	Poly-silicon	Low	Mainly a construction materials company. Silicon contributed to ~5% of 1H10 revenue.

Source: BofA Merrill Lynch Global Research

Biomass power appears interesting while bio-fuel are facing significant challenges.

Bio energy

Biomass power appears interesting while bio-fuel are facing significant challenges.

Biomass power

Exhibit 5.1: Biomass power

Source: BofA Merrill Lynch Global Research

The term "biomass" covers fuels generated from forestry waste, agriculture and food processing wastes and crops that are specifically grown or reserved for power generation.

Theoretically, biomass power is clean, low cost, and rich in resources. It is listed as one of the most important new energy sources by the government and enjoys many policy supports (Table 5.13).

Table 5.13: Tariff, tax incentives and financial subsidies to biomass power

Tariff subsidies	local benchmark price plus Rmb0.35/kWh
Tax incentives	10% off of total income tax
Material subsidies	Rmb100 ~150/ton subsidy for each ton of straw utilized
CDM subsidies	expected to receive CDM subsidies

Source: BofA Merrill Lynch Global Research

China's Biomass power is still at its infancy stage. Despite government support, the industry still faces many challenges including high construction and operating costs, high collection, transport and storage costs, unstable fuel supply and unstable fuel prices.

Main players in the biomass power industry include Wuhan Kaidi (000939), GuangDong Shaoneng (000601), and DP CleanTech (not listed).

Bio-fuel

Bio fuel appears to be an arbitrage between food price and energy price - it is most profitable when oil price is high and food price is low. Given China's food security concerns, we don't expect the government to actively encourage food to fuel conversion.

Guangxi was the first Chinese province to have aggressively promoted ethanol gasoline and started to ban normal gasoline sales in local gas stations in April 2008. But consumers have been complaining about weaker engine power, high oil consumption, oil tank erosion and engine failures. According to Daily Economic News, Guangxi has recently lifted the ban.

"Waste cooking oil to biodiesel" also faces a lot of challenges including security of supply of low cost waste cooking oil. Chinese players include Gushan (GU US).

Smart grid

Smart grid is necessary for the new energy industry.

Smart grid is closely related to the new energy industry. Power grid is often a bottleneck for the development of new energy sources, particularly wind and solar. China is planning to build a powerful smart grid, to reduce transmission bottlenecks (with long distance / high voltage transmission as the backbone), enhance safety & reliability, improve energy efficiency, and to accommodate the massive renewable energy capacity China is going to build.

Objectives of a smart grid

The smart grid concept came into being in 2001 in the US (for expert views on the challenges and the future of smart grid, please have a look at Experts Discuss the Smart Grid Outlook, 14 June 2010, by Steven Milunovich). A smart grid is reliable & safe (e.g. dealing with extreme weathers and reducing power failures), self-healing / automated (e.g. online analysis, predictive control strategy), efficient (e.g. lower transmission loss), open (e.g. capable of supporting distributed power generation, say solar, and handling more new energy sources, say solar & wind, which are volatile in nature) and user friendly (e.g. able to support electric car development).

Table 5.14: Traditional grid vs. smart grid

	Traditional grid	Smart grid
Communication	One-way	Two-way
Interaction with consumers	Minimum	A lot
Meters	Mechanical	Digital
Management	Manual	Automated
Supported power generation	Concentrated generation	Concentrated + distributed generation
Reliability	Prone for failure	Automated protection
Recovery	Manual	Self-healing
Shape of the grid	Emission pattern	Net pattern

Source: BofA Merrill Lynch Global Research

China plans to invest big in smart grid.

Ambitious investment plan

China plans to develop its smart grid in three stages: research stage (2009-2010), rollout stage (2011-2015) and enhancement stage (2016-2020). According to China Radio, the State Grid plans to spend Rmb500bn on smart grid from 2011-2015. Southern Grid, which is about 1/5 ~ 1/4 of the size of State Grid, also has its own smart grid plans, although the company hasn't disclosed the details yet.

On Jan 14, 2010, State Grid gave out more details of its plan:

- In 2010, starting construction of ultra high voltage AC backbone transmission network; strengthening key technology research and completing pilot tests.
- By 2015, finishing the construction of the backbone network; making significant progress in automation; enabling large scale renewable energy collection; ultra high voltage long distance transmission capacity reaching 240GW; smart meters widely introduced; electric car charging stations satisfying the development of the industry.
- By 2020: enhancing the backbone network; ultra high voltage long distance transmission capacity reaching 400GW; significant improvement in resources allocation, safety, efficiency, and power grid interaction (with consumers).

It highlighted the following areas for significant investment: power source connection (wind power, solar power, and electricity storage projects, pumped storage power stations), transmission (FACTS - flexible AC transmission system, HVDC transmission - high-voltage direct current); transformation (intelligent substations, energy efficient transformers), distribution (power storage, electric car charging stations, and distribution automation), dispatching (intelligent/integrated dispatching, rural power grid upgrade) and at the consumer end (smart meters, charging stations for electric cars).

Companies exposed to smart grid

Table 5.15 lists companies with exposure to smart grid.

Table 5.15: Exposures to smart grid

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
2188 HK	China Titans Energy	0.1	Power grid monitoring	Medium	It manufactures electrical DC products, charging equipment for electric vehicles, power grid monitoring and management products, and wind and solar power generation control products. Main customers are IPPs, transforming stations, and large scale electricity users like railways.
1685 HK	Boer Power	0.7	Power distribution systems	Medium	It focuses on the high-end power distribution system market, providing hardware, software and system integration services.
CHNS LN	China Shoto PLC	0.1	Power supply systems.	Medium	It provides industrial batteries and power supply systems.
600089 CH	TBEA	5.9	Ultra-high voltage transformer	High	A power grid equipment vendor (transformers, cables), with growing solar presence. 1H10 revenue breakup: transformers 58%, cables 19%, solar 14%. The company also has a stake in the 2nd largest domestic wind turbine maker, Goldwind.
600550 CH	Tianwei Baobian	4.2	Transformers, solar, wind	High	A transformer maker, 45% of domestic market share, the only qualified domestic transformer vendor for nuclear power plants. Also a supplier of solar power equipment and wind power equipment.
601179 CH	China XD	5.3	High voltage transformers, switches, capacitors, and etc.	High	A vendor of high voltage and ultra high voltage equipment, the biggest winner of State Grid's Phase-I tender.
000400 CH	XJ Electric	1.9	Automation of power systems	High	A power grid equipment vendor. Main products include transfers, plant protection and automation, power grid dispatching, substation automation, and distribution system automation. The company plans to acquire a controlling stake in Xuji Power Supply Equipment, a sister company, from its parent. The latter has footprints in charging stations, but the business is still at the early stage.
002123 CH	Rongxin Electronic	2.5	SVC, SVG	High	An energy saving power electronic equipment vendor. 2009 Revenue breakdown: power quality management products 65% (SVC ~52%), variable frequency products 17%, residual heat/pressure power generating system 13%. The company's solar power converter has begun to contribute to revenue while wind power converter is still at the test stage. 2Static Var Compensator (SVC), the company's most important product, is used to improve power grid quality and reduce energy consumption.
600590 CH	Tellhow Sci-Tech	0.9	Intelligent buildings	High	The company's main product, electrical equipment for intelligent buildings, is designed to help reduce energy consumption of buildings. 60% of its 1H10 revenues came from such products. Tongfang Artificial Environment, one of the company's subsidiaries, is a producer of heat pumps.
000682 CH	Dongfang Electronics	0.8	Automation of power systems	Medium	Electrical automation, electronic equipment and system integration.
600268 CH	Guodian Nanjing Automation	1.1	Automation of power systems	High	A power automation equipment vendor. Main products include power grid protection and automation, power plant protection and automation, industrial automation, and hydropower automation. The company set up a new energy subsidiary with main products being wind power control system, solar power inverter boosters, nuclear power auxiliary products, frequency converters and vacuum cleaner. The company also has a 30% in a desulfuration (activated carbon) company.
600406 CH	NARI Tech	6.0	Power grid equipment	High	A power grid equipment vendor. Main products include substation automation, electric network management automation, and metro electric automatic/protection system.
600112 CH	Changzheng Electric	0.7	Full equipment	High	An electrical products producer (electrical components, relay protection, and full electrical equipments), also produces auto parts (connecting rods). 2009 revenue breakdown: electrical products 90%, auto parts 6%. The company is getting into the wind power equipment business, its products are most suitable for off-shore wind farms.
600290 CH	Huayi Electric	0.6	Electric transmission equipment	Medium	1H10 revenue breakdown: Electric transmission and transformation equipment 46%, wind power equipment 52%. Wind power equipment has overtaken its traditional business as the main revenue driver.
000806 CH	Yinhe Hi-Tech	0.6	Grid control	Medium	A power system automation equipment vendor. 83% of its 1H10 revenues came from such products.
002028 CH	Sieyuan Electric	1.6	Smart components	Medium	A power grid equipment vendor. Main products include high voltage switchgear, power system protection equipment and high-voltage transformer.
002074 CH	Dongyuan Electrical	0.4	Smart components	Low	An electrical product vendor. Switches and switchgears, the most important product, contributed to 86% of its 1H10 revenues.
600312 CH	Pinggao Electric	1.8	Smart components	Medium	A vendor of high voltage and ultra high voltage switches.
002121 CH	Clou Electronics	1.2	Smart meters	High	A power distribution equipment vendor, including smart (electricity) meters. One of the few domestic firms that have high-current fast charge (charging station) technology. Frequency converter business was set up in 2008, so still at the early stage.
600416 CH	Xiangtan Electric	1.4	Other equipment	Medium	An AC electromotor and pump maker. But Wind power equipment has become the largest business, contributed to 56% of its 1H10 revenue. The company also produces pumps for nuclear power plants.
600005 CH	Wuhan Steel	5.3	Silicon steel	Low	A silicon steel vendor. Silicon steel is widely used in power grid products, especially transformers. Competition is going up as more steel makers (i.e. Angang, Valin) get into this space.
358 HK/600362 CH	Jiangxi Copper	13.6	Copper	Low	Copper is widely used in power grid equipment.

Source: BofA Merrill Lynch Global Research

New materials

The State Council announcement on the seven strategic industries lists the following sectors as keys to its new materials initiatives: rare earth, high performance membrane, special-usage glass, functional porcelain, semiconductor lighting materials; high performance special steel, new alloy, and engineering plastics; high-performance fibers and composites; nano, superconducting, intelligent materials (Table 6.1).

Table 6.1: New materials sector overview

Targeted areas	Policies	Relevant stocks
Rare earth, high performance membrane, special-usage glass, functional porcelain, LED （稀土功能材料、高性能膜材料、特种玻璃、功能陶瓷、半导体照明材料）	The government may raise industry standards, push for industry consolidation, provide more tax benefits (VAT, business tax, corporate income tax), subsidies and funding support.	Rare earth: China Rare Earth (769 HK), Baotou Steel Rare-Earth (600111 CH), Rising Nonferrous (600259 CH) Magnetic materials: Zhong Ke San Huan (000970 CH), Ningbo Yunsheng (600366 CH), Taiyuan Aluminum Oxide (000795 CH), BGRIMM Materials (600980 CH), Sinosteel Anhui Tianyuan (002057 CH), TDG (600300 CH), Dingtai Rare Earth & New Material (002352 CH) MBR: Originwater (300070 CH) Li-ion battery separator: Cangzhou Mingzhu (002108 CH), FSPG (000973 CH) High temperature filter: Xiamen Savings (300056 CH) Wafer & Chips: Sanan Optoelectronics (600703 CH), Silan Microelectronics (600460 CH), Xiamen Changelight (300102 CH), Tianfu Thermoelectric (600509 CH), TDG (600300 CH), Tsinghua Tongfang (600100 CH) Packaging: Lianchuang Optoelectronic (600363 CH), Tianshui Huatian Tech (002185 CH) Applications: Neo-Neon Holdings (1868 HK), Gold Peak Industries (40 HK), China Intelligent Lighting (CIL US), LED International (LED LN), Nationstar Optoelectronics (002449 CH),Foshan Electrical and Lighting (000541 CH), Zhejiang Yankon (600261 CH), Cnlight (002076 CH), Feilo Acoustics (600651 CH)
High performance special steel, new alloy, and engineering plastics (高品质特殊钢、新型合金材料、工程塑料）		Special Steel: Baosteel (600019 CH), Citic Pacific Ltd (267 HK), Shanxi Taigang Stainless (000825 CH), Xining Special Steel (600117 CH), Hebei Iron Steel (000709 CH), Zhongyuan Special Steel (002423 CH), Hunan Valin (000932 CH), Shougang (000959 CH) New alloy: Nanjing Yunhai (002182 CH), Aluminum Corp (601600 CH), Sino-platinum (600459 CH), Xiamen Tungsten (600549 CH), Baoji Titanium (600456 CH), Jiaozuo Wanfang (000612 CH) Polymer resin: Petrochina (601857 CH), Sinopec (600028 CH), Shanghai Pret Composites (002324 CH) EP: Shenma (600810 CH), Sinochem (600500 CH), Blue Star (600299 CH), inopec Yizheng Chemical (600871 CH), Yunnan Yuntianhua (600096 CH) PAN: Petrochina (601857 CH), Yunnan Yuntianhua (600096 CH), Sinopec Shanghai (600688 CH)
High-performance fibers and composites （碳纤维、芳纶、超高分子量聚乙烯纤维等高性能纤维及其复合材料）		Carbon fiber: Sinosteel Jilin Carbon (000928 CH) Carbon fiber prepreg: Ningxia Dayuan Chemical –A (600146 CH) Composite: Hunan Boyun New Materials (002297 CH) Aramid: Yantai Spandex Co Ltd –A (002254 CH) UPMWPE: Sinopec Yizhen (600871 CH), Sinotex (600061 CH) Nano material: AT&M (000969 CH)
Nano, superconducting, intelligent materials（纳米、超导、智能等共性基础材料）		Superconducting material: Qingdao Hanhe Cable (002498 CH), Baosheng Science and Tech (600973 CH), Jiangsu Zongyi (600770 CH) Intelligent material: Fasten Group (000890 CH), SDG Information (000070 CH), YCIG wireless (600345 CH)

Source: BofA Merrill Lynch

Rare earth materials

China has abundant reserve of rare earth minerals …

Rare earth elements are a collection of 17 chemical elements in the periodic table, namely scandium, yttrium, and the fifteen lanthanides. They are among the few minerals that China has rich reserves. Deng Xiaoping had famously said in the early 1990s that "The Middle East has its oil, China has rare earth: China's rare earth deposits account for 80 percent of identified global reserves, you can compare the status of these reserves to that of oil in the Middle East: it is of extremely important strategic significance; we must be sure to handle the rare earth issue properly and make the fullest use of our country's advantage in rare earth resources." Perhaps partly as a result, in recent years, the government has been trying to prevent unsustainable rare earth exports.

Widely used in the environmental industry

… which are widely used in the environmental industry.

Rare earth is arguably one of the biggest winners of the environmental industry advancement. Wind power and electric cars may become the most important drivers of demand. Energy saving lamps and LED also use rare earth materials.

Each of the rare earth elements has wide applications in the environmental industries. For example permanent magnetic materials (wind power, electric car, inverter air conditioners and etc.), refinery catalysts and exhaust gas cleanup catalysts, fluorescent materials (for LED and CFL), hydrogen storage materials (for new energy cars), anti-rot materials, polishing materials (for semiconductors, LED, LCD, and etc) and so on (Table 6.2).

Table 6.2: Key industries that use rare earth materials

Application	Elements	Products
Magnetic materials	Nd, Pr, Dy, Tb, Sm	Electronics, high performance motors
Hydrogen storage alloys	La, Ce, Pr, Nd	Battery
Tail gas cleanup catalyst	Ce, La, Nd	Fuel additives
Petrochemical catalyst	La, Ce, Pr, Nd	Refinery
Luminescent materials,	Eu, Y, Tb, Dy, La, Ce, Pr, Gd LCD	TV, LCD, LED, fluorescent lamps
Polishing powder	Ce, La, Pr	TV, LCD, LED, fluorescent lamps, silicon wafers/chips
Additives to glass	Ce, La, Nd, Gd, Yb, Er	Optical glass, optical fiber

Source: BofA Merrill Lynch Global Research

Export control

Table 6.3: Major export markets of Chinese rare earth

	2009	1-5m10
Japan	34.10%	46.60%
US	34.00%	19.60%
Europe	20.30%	20.30%
Hong Kong	6.10%	6.70%
Others	5.50%	6.80%

Source: China Rare Earth, BofA Merrill Lynch Global Research

China's rare earth industry is very fragmented, as a result of minimum regulation and local governments' enthusiasm for exports. According to Xinjiang Bao, China rare earth exports jumped by 10X from 1990 to 2007 although China's proven reserves as % of the total had dropped from 85% to 58% during the same period (more discoveries overseas). China's rare earth producers were competing fiercely among themselves and many foreign vendors were squeezed out of the market. Average rare earth prices dropped by ~64% from 1990 to 2007, as a result of China's aggressive exports. Table 6.3 shows the destinations of China's rare earth exports.

China is limiting rare earth's exports.

In recent years, China has tried to consolidate the industry and limit exports, often citing pollution as a main reason. In the 2009 Rare Earth Industry Development Plan, MIIT made it clear that China's rare earth exports would be no more than 35,000 tons a year, from 2009 to 2015. According to Reuters, China only issued export quotas for 30,258 tons by the end of July, 2010, down 40% YoY, following a nationwide campaign to consolidate the sector and clamp down on illegal production.

In our view, China's own ambitious plan to develop its green industries could be one of the key reasons behind the export crackdown. Besides, there is less a need for China to earn export dollars nowadays.

Hoarding, smuggling & skyrocketing prices

Prices are firm.

The immediate result of reduced quotas is hoarding (both domestically and overseas), smuggling, and a jump in prices. According to our Japanese electronics material analyst Takashi Enomoto, most Japanese companies are holding substantial inventories, so China's quota slash will not have any immediate impact on them. Key Japanese importers include Hitachi Metals, Shin-Etsu Chemical, Showa Denko, Showa Denko and Hitachi Chemical.

Over time (at least 2 years), we expect overseas production will ramp up, and shortage will be alleviated (Takashi Enomoto, “Rare earth supply concerns”, 29 Sep 2010). Nevertheless, we suspect that rare earth prices may remain high because most low cost reserves are located in China and demand is rising fast.

Magnetic materials - electric car & wind power to drive demand growth

Magnetic material has become the most important application for rare earth.

Magnetic material has become the most important application for rare earth. Rare earth permanent magnetic material (Nd-Fe-B) made from neodymium (Nd) and praseodymium (Pr) for example is widely used in many industries, including traditionally the defense industry (precise weapons, missiles, electronic jamming equipments and etc) and electronics industry, but wind power turbines (direct drive) and high performance motors (electric cars, Inverter air conditioners) would probably become the biggest drivers for demand in the future (Chart 6.1).

Chart 6.1: Key down stream demand sources for permanent magnetic materials

Electronics products

Wind power

Electric cars

Inverter air conditioners

Source: BofA Merrill Lynch Global Research

Demand outlook for magnetic materials looks robust because:

1) Traditional applications will grow steadily i.e. electronics, AV, home appliances, mobile phones, auto, aviation, precise weapons, healthcare (magneto therapy), and some consumer products.

It’s critical to the wind power and electric car sectors.

2) Demand from the green industries should grow rapidly in the coming years, in our view, as direct drive wind turbines are gaining market share (please refer to our Environmental section); permanent magnet synchronous motor (PMSM) is becoming the preferred motor for electric cars (please refer to our New Energy Car section); and inverter air conditioners are set to replace traditional air conditioners.

- Each 1MW wind turbine (direct drive permanent magnetic) needs 1 ton;
- Each electric car (PMSM) needs 16kg of magnetic materials;

- Each hybrid car needs 2kg;
- Each Inverter air conditioner needs 1/4 kg;

According to A.T. Kearney's estimates, 17% of the global auto market will be electric cars (HEV, PHEV & EV) by 2020. Global auto sales are forecast to reach 75mn units by 2020 so some 13mn will be electric cars. If we assume a usage of 10kg of permanent magnetic materials per electric car, demand from this source along will be 130,000 tons a year. According to World Wind Energy Web, the wind power industry used ~2,000 tons of permanent magnetic materials in 2010, up 62% YoY. The demand is growing fast as direct drive wind turbines gaining market share. To put these numbers in context, the world only produced ~93,000 tons of permanent magnetic materials in 2009, of which, ~70,000 tons were made in China.

Key players along the value chain

The upstream players in the value chain are the mining companies (17 rare earth elements). The most expensive elements, e.g. europium (Eu) and dysprosium (Dy), can be ~100x more expensive than the cheap elements, e.g. Cerium (Ce). China's current export quota system does not differentiate between the elements. So vendors want to export the expensive elements. Broadly speaking, the higher value minerals are generally mined in the south, while the cheaper ones, in the north.

Domestic vendors used to focus on mid-low end products, but they are moving up the value chain. Listed key players are contained in Table 6.4. Zhong Ke San Huan (000970 CN) is the leading domestic producer of magnetic materials at the moment. Its products can reach N52 in magnetic power, currently the highest among domestic vendors. In comparison, Hitachi's can reach N54; Ningbo Yunsheng's, N50; Taiyuan Aluminum Oxide's, N48.

Table 6.4: Exposures to rare earth, magnetic materials

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
769 HK	China Rare Earth	0.8	Rare earth	High	Rare earth contributed to 64% of its 1H10 revenue. Key products are rare earth oxides and rare earth downstream products, e.g. fluorescent materials. It also produces refractory products (36% of its 1H10 revenue).
600111 CH	Baotou Steel Rare-Earth	8.8	Rare earth	High	A rare earth producer. It's also a leading Nd-Fe-B magnetic material vendor with a current capacity of ~3,000 ton/year. It has another 12,000 tons/year capacity under construction.
600259 CH	Rising Nonferrous	2.5	Rare earth	High	Rare earth contributed to 83% of its 1H2010 revenues.
000970 CH	Zhong Ke San Huan	2.2	Magnetic materials	High	An associate company of China Science Academy, the largest domestic vender with a capacity of ~11,500 ton/year. Also one of the world's largest Nd-Fe-B magnetic material producers. Nd-Fe-B is 3rd generation rare earth permanent magnetic material and its magnetic force is much stronger than conventional magnetic materials.
600366 CH	Ningbo Yunsheng	1.6	Magnetic materials	High	The second largest Nd-Fe-B magnetic material producer with an annual capacity of ~5,000 ton. magnetic material contributed to 70% of its 2009 revenues.
000795 CH	Taiyuan Aluminum Oxide	0.8	Magnetic materials	High	A leading Nd-Fe-B magnetic material vendor which contributed to 78% of its 1H10 revenue. Current capacity at 3,000 - 5,000 tons/year with more under construction (over 1000 tons/year). The company was traditionally a brown aluminum oxide vendor.
600980 CH	BGRIMM Materials	0.6	Magnetic materials	High	A leading high-performance permanent magnetic materials vendor. Main products are bonded ferrite and sintered ferrite.
002057 CH	Sinosteel Anhui Tianyuan	0.3	Magnetic materials	High	Magnetic materials contributed to 55% of its 1H2010 revenues. Main products are manganese oxide soft magnetic materials.
600300 CH	TDG	1.5	Magnetic materials	High	A magnetic materials vendor with ferrite cores as its key product. The company's magnetic material business swung back to profit in 1H10 driven by strong sales. It invested RMB100mn in a JV (with Japanese partners, MAT, KDN) to product 4" sapphire substrate. Production expected in 2011.
600366 CH	Ningbo Yunsheng	1.6	Magnetic material	High	The company has a wholly-owned subsidiary mainly engaged in production and sales of sintered and bonded Nd-Fe-B magnets as well as magnetic components. The company started neodymium magnets manufacturing from 1996, and has set up advanced production lines with annual in-house capacity of 5,000-ton sintered magnets and 300-ton bonded magnets. The company has two magnetic material plants located in Ningbo and Baotou for magnets manufacturing, one machining factory for machining processes and one plating house for surface treatment located in Ningbo.
002352 CH	Dingtai Rare Earth & New Material	0.4	Anti-rot materials	High	The company is a producer of high end rare earth anti-rot coated materials used in power grids, electrified railway, IT, expressway and etc. Key product: rare earth alloy coated steel wire.

Source: BofA Merrill Lynch Global Research

High-performance membrane

High-performance membrane is used in ...

It's used in waste water treatment, Li-ion batteries and dust removals.

Membrane bioreactor (MBR)

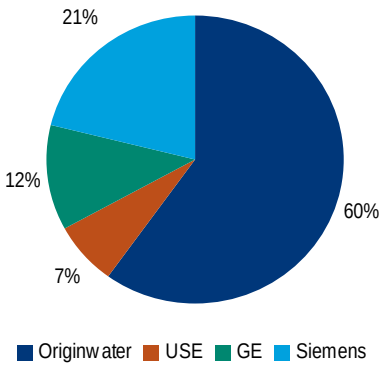
With the growing concern over water pollution and water shortage, many regions in China are strengthening waste water discharge standards. MBR is commonly used in the tertiary stage of waste water treatment. Despite its high cost, the application of MBR is growing in China.

... waste water treatment ...

The three stages of waste water treatment are:

- Primary treatment - Physical filtration and chemical treatment;
- Secondary treatment – Apart from physical and chemical processes, biological degradation is used to remove toxins from the water;
- Tertiary treatment – Membrane technology is most commonly used as it provides water of the highest quality.

Chart 6.2: Market share of domestic MBR market 2005-2007



Source: Global MBR Wastewater Treatment System Engineering Status and Prospects, BofA Merrill Lynch Global Research

In 2008, MBR was named in the "Directory of environmental protection technologies that are encouraged by the State". Partly as a result, China has become one of the fastest growing regions of MBR application.

Originwater (300070 CH) is the leading membrane maker for waste water treatment in China, with ~60% domestic market share (Table 6.5)

Table 6.5: Exposures to MBR

Company	Ticker	Market cap (USD bn)	Market share
Originwater	300070 CH	2.9	60%

Source: BofA Merrill Lynch Global Research

Lithium-ion battery (Li-ion battery) separator

The separator is the key inner layer of Li-ion battery. High-performance membrane plays an important role to improve the overall quality of Li-ion battery. For example, it largely determines the battery's interface structure & resistance; it also directly affects the battery's capacity, recycling and safety performance.

Li-ion battery separator is made from polyethylene (PE) and polypropylene (PP). There are two production processes for the separator: dry process and wet process with Pore Formation mechanism of membrane being the main difference. The dry process is simple, clean and widely adopted at the moment. But it's difficult to control the pore size during the process and the separator made is usually thick. On the other hand, the wet process, adopted by the likes of Asahi, Tonen and Entek, can solve this issue but the technology is more complicated and mastered by fewer makers.

... Li-ion battery ...

Because of the industry's high-tech, high capital intensity, high risk and long cycle nature, it has been dominated by a few foreign companies, including Asahi Chemical, Tonen Chemical, and Celgard. China has only a handful of companies that can produce membrane for Li-ion battery and the country has to rely heavily on imports.

The following local companies are in this space (Table 6.6): Foshan Plastic (000973 CH): it has a joint venture with BYD, Jinhui High-tech Co., making Li-ion battery separator. Jinhui High-tech is the first company in China that uses the wet process. Shenzhen Senior Technology Material Co., unlisted, uses both dry and wet processes. Cangzhou Mingzhu (002108 CH) is conducting research in Li-ion battery separator.

Table 6.6: Exposures to Li-ion battery separator

Company	Ticker	Market cap (USD bn)	Market share
Cangzhou Mingzhu	002108 CH	0.5	NA
Shenzhen Senior	unlisted	NA	NA
Foshan Plastic	000973 CH	1.5	NA

Source: BofA Merrill Lynch Global Research

High temperature filter

... and dust collection.

High-temperature filter is used for dust removal. The Sate Council highlighted particle control in its "Opinions to Improve Air Quality" announced in May 2010. Please refer to the "Dust removal" sector in "Energy Saving & Environmental Protection" section of this report for more details.

Other important new materials are special usage glass, …

Special usage glass

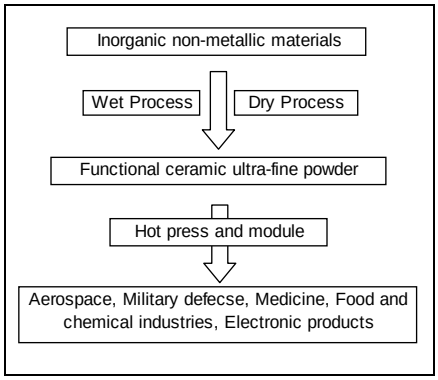
Low-E glass is the industry focus. Please refer to the "Energy Saving & Environmental Protection" section for details.

Functional ceramics

Functional ceramics were developed for use in advanced ceramic engineering, for example, in semiconductors. They include ferroelectric ceramics, thermosensitive ceramics and photosensitive ceramics. Before the latest State Council announcement, functional ceramics were also mentioned in its 2005 announcement of "Interim Regulations on Promoting the Adjustment of Industrial Structure" and NDRC's catalogue of industries where foreign investment is encouraged that was released in 2007.

As ceramics are heat resistant, they can be used for many tasks that materials like metal and polymers are not suited for. They are used in a wide range of industries, including mining, aerospace, medicine, refinery, food and chemical, packaging, electronics, and electricity transmission. For example, the Space Shuttle program, gas burner nozzles, ballistic protection, nuclear fuel uranium oxide pellets, bio-medical implants, jet engine turbine blades, and missile nose cones all use ceramic tiles. By 2015, ceramic industry output in China is expected to reach Rmb45bn with functional ceramics to account for 70% of the total output, according to the forecast from Chinese Academy of Sciences.

Chart 6.3: Value chain – Functional ceramics



Source: BofA Merrill Lynch Global Research

… functional ceramics …

Chart 6.3 shows the industry value chain. There is quite a large gap between China and the advanced countries in the level of application development, production and industrialization of functional ceramics. Most high-end products are still imported.

Unfortunately, we haven't managed to identify any listed company with any meaningful exposure to functional ceramics.

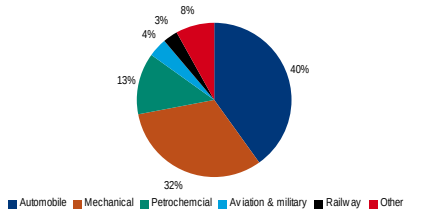
High-performance special steel

… special steel …

Special steel is steel alloys that can provide special performance features. In recent years it has become a focus of Chinese government. For example, in Mar 2009, the government announced its Steel Industry Restructuring and Revitalization Plan which aims to strengthen the domestic steel industry through technology innovation, co-operative R&D and product upgrade, in which, special steel featured prominently.

Market opportunity

Chart 6.4: Split of special steel end users



Source: China Special Steel Industry Association, BofA Merrill Lynch Global Research

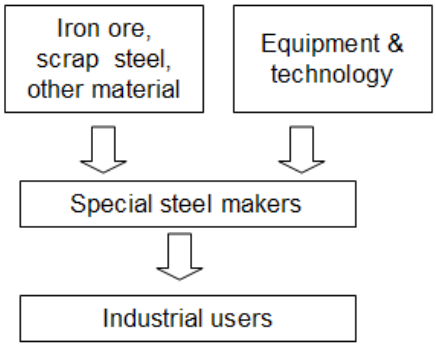
Specialty steel is used extensively in China's industrial sectors (Chart 6.4) and is an essential ingredient for China's strategic industry initiatives. For example, corrosion-resistant steel is needed for nuclear power plants (new energy), steel with high safety and reliability features for high-speed rail bogie (high-end equipment), light-weight but high-strength steel for automobile (new energy car). However, China's special steel output lags far behind its overall steel output. In 2009, special steel only accounted for 5% of China's steel output, vs. the usual 10-20% in developed countries. Partly as a result, China has to rely heavily on imports. For example, China has to import all its alloy-690 heat exchanger tube needs for its rapidly expanding nuclear power program – there are only three steel makers worldwide that can make it and none of them is based in China.

Technology barrier is high as extensive knowledge and experience is required. Capital investment is substantial: a production line usually costs several billions of Rmb. Competition is limited as customers usually ask for tailor made products and prefer suppliers with proven track record. Gross margin is around 20-30%, much better than regular steel's (around 10% normally). Right now, foreign companies still dominate this market in China, especially at the high end.

Key players along the value chain

The industry value chain is shown in Chart 6.5. Other than materials for regular steel, special steel also uses many additives including silicon and magnesium. Foreign makers still dominate equipment and technology supply to the industry. A recurrent problem is that, after importing the equipment, domestic steel makers struggle to efficiently integrate production and control quality. Table 6.7 lists some of the domestic steel makers that have an exposure to the special steel market.

Chart 6.5: Value chain – special steel



Source: BofA Merrill Lynch Global Research

Table 6.7: Exposures to special steel

Company	Ticker	Market cap (USD bn)	Market share	Product type
Baosteel	600019 CH	16.8	NA	Regular + special steel
Citic Pacific Ltd	267 HK	9.0	NA	Regular + special steel
Shanxi Taigang Stainless	000825 CH	4.6	NA	Regular + special steel
North-eastern Special Steel	Not listed	NA	NA	Special steel only
Xining Special Steel	600117 CH	1.0	NA	Special steel only
Hebei Iron & Steel	000709 CH	4.0	NA	Regular + special steel
Tianjin Steel Pipe	Not listed	NA	NA	Special steel only
Zhongyuan Special Steel	002423 CH	0.7	NA	Special steel only
Hunan Valin	000932 CH	1.6	NA	Regular + special steel
Shougang	000959 CH	2.0	NA	Regular + special steel

Source: China Special Steel Industry Association, BofA Merrill Lynch Global Research

New alloys

... new alloys ...

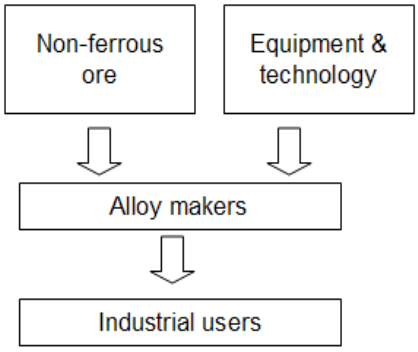
New alloy refers to non-steel based alloys, such as those based on aluminum or magnesium. Similar to the situation in the special steel sector, Chinese makers lag behind global peers in making new alloys. The government has shown strong support to the industry. For example, in its "Nonferrous Metals Industry Mid-Long Term Technology Development Plan (2006-2020)" announced in 2006, new alloy was targeted as a key development area.

Market opportunity

The low end market is commoditized while imports dominate the high end market. As many of the new alloys are used in the defense industry, China often has difficulty importing related technologies so it has to rely on in-house research. Local competition is limited. For example, China did not have its first production line of Mg-Li alloy (used in aerospace and high-speed transmission device) till Sept 2010, and the company finds itself often charging as little as 1/20 of the prices charged by its overseas competitors.

There are a few alloys China is keen to develop and they include light-weight structural alloy, hydrogen storage alloy and shape memory alloy. Light weight structural alloys can be based on aluminum, magnesium, lithium, and titanium. China has developed some capacities in the mid-to-low end market, but still relies on imports for high-precision & high-performance materials. Hydrogen storage alloy is widely used in new energy and new energy car industries. By adding rare earth, these alloys can make storage tank larger, more energy efficient, better at handling pressure, and easier to use. Shape memory alloys are widely used in aerospace and bio-pharmaceutical industries. The alloys are highly plastic and can bend and restore to different shapes at various temperatures. They are usually made from nickel, titanium, zinc, and aluminum.

Chart 6.6: Value chain – new alloy



Source: BofA Merrill Lynch Global Research

Key players along the value chain (Chart 6.6)

Different from the special steel industry, most new alloy makers are regular alloy producers as well. Table 6.8 lists some of the key players in the industry.

Table 6.8: Exposures to new alloy

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
002182 CH	Nanjing Yunhai	0.5	Magnesium alloy, aluminum alloy	High	Lightweight structural alloy (Mg alloy) for automobile and aviation industries. Its major foreign competitors include Alcoa, Rima, Alcan and Timminco.
601600 CH	Aluminum Corp	18.3	Aluminum alloy	High	The major player in aluminum alloy sector
600459 CH	Sino-Platinum	0.6	Precious alloy	High	A professional manufacturer of precious metal alloys that used in aviation, bio-pharmaceutical and new energy sector
600549 CH	Xiamen Tungsten	4.9	Hydrogen storage alloy (rare earth)	High	The world largest tungsten smelters.It produces hydrogen storage alloy using rare earth.
600456 CH	Baoji Titanium	1.8	Titanium alloy	High	A subsidiary of Baoti Group Ltd, is China's largest supplier of Titanium alloy maker.
000612 CH	Jiaozuo Wanfan	1.6	Aluminum alloy	High	The company mainly focuses on high-strength high-toughness aluminum alloy

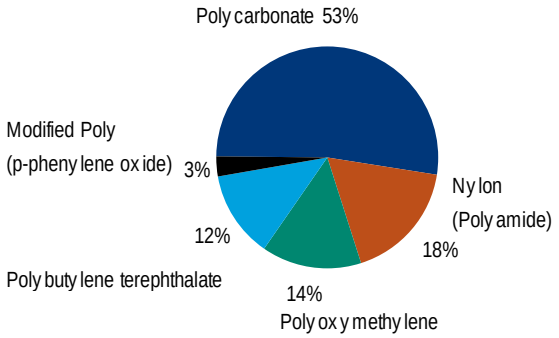
Source: BofA Merrill Lynch Global Research

Engineering plastics

... engineering plastics ...

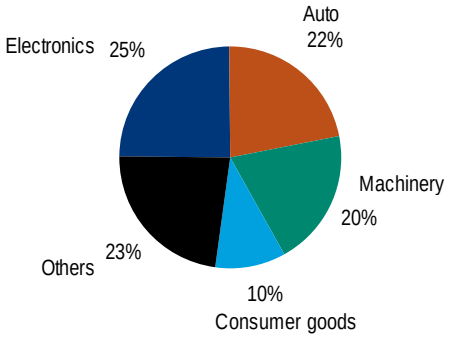
Engineering plastics (EP) are plastics achieving high performance in strength, hardness, resistance to heat, impact and aging. Base on the temperature level,EP are divided into general EP (Chart 6.7) and special EP. In many applications, EP has replaced steel, copper and aluminum. Given the broad range of its applications and a low self-sufficiency in China, the government has been a strong supporter to the industry, for example, it has included EP development in its Rmb4tr stimulus plan announced in May 2009.

Chart 6.7: General EP usage - by products (2010)



Source: CEPIA, BofA Merrill Lynch Global Research

Chart 6.8: EP demand 2009 - by customers



Source: CEPIA, BofA Merrill Lynch Global Research

Market opportunity

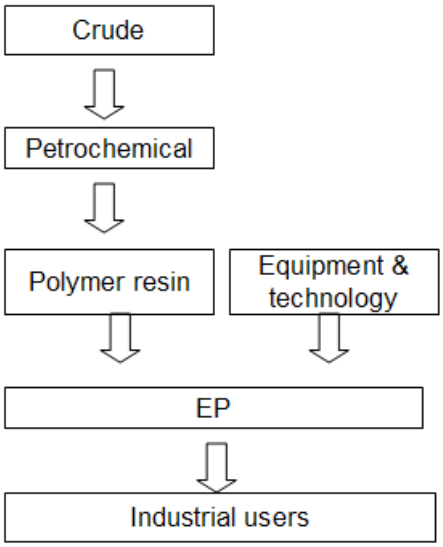
The market is characterized by high growth, high entry barrier and a dominant position by global makers. Demand has been strong in recent years because of healthy growth of its key downstream users, i.e. electronics, auto and machinery (Chart 6.8). Entry barrier is high because 1) technology requirements are high (China has to rely on imported technologies but foreign companies are unwilling to sell the good ones), and 2) customer preference - most customers are large manufacturers who are demanding in terms of products' performance track record. As a result, major global players, such as Dupont and BASF, dominate the market. China only started to produce EP in the late 1990's. For special EP, it is only in recent years that China managed to import some.

A major bottleneck in the domestic EP market is the supply of high-end polymer resin - China still imports about 40% of its annual demand here. This also adds to the competition in the EP market. Global players often integrate the production of resin and EP, so their products are often cheaper and have better performance.

Industry margin for domestic producers has declined over the past few years mainly for two reasons: 1) down stream customers, such as auto and electronics, faced mounting pressure to cut prices; 2) high material and energy prices. Polymer resin is the main raw material and China still has to import most of its high-end needs (although the low end segment has become commoditized).

Key players along the value chain (Chart 6.9)

Chart 6.9: Value chain - EP



Source: BofA Merrill Lynch Global Research

Table 6.9 lists some listed companies involved in the EP sector, including raw material suppliers and EP makers. Below is a brief description on some of them.

Sinopec: its JV with BASF in Nanjing (Yangtze BASF, not listed) and its JV with BP in Shanghai (via its Shanghai Petrochem subsidiary) are major polymer resin makers in China. Its subsidiary, Yizheng (600871 CH) is a major general EP maker in China.

PetroChina: its subsidiaries in north-east China (Daqing, Jilin) are major polymer resin makers.

ShenMa: a major general EP maker in China. Its PA66 (Nylon 66) capacity ranks No.1 in China and No.4 worldwide.

Sinochem: its subsidiary Blue Star is a major general EP maker in China.

PRET: a private company involved in polymer resin and special EP.

Table 6.9: Exposures to polymer resin & EP

Company	Ticker	Market cap (USD bn)	Market share	Product type
Petrochina	601857 CH	305.2	NA	Polymer resin
Sinopec	600028 CH	100.8	NA	Polymer resin + general EP
Shenma	600810 CH	0.7	NA	General EP
Sinochem	600500 CH	2.3	NA	General EP
Blue Star	600299 CH	1.0	NA	General EP
Sinopec Yizheng Chemical	600871 CH	4.7	NA	General EP
Yunnan Yuntianhua	600096 CH	2.1	NA	General EP
Shanghai Pret Composites	002324 CH	0.9	NA	Polymer resin + special EP

Source: BofA Merrill Lynch Global Research

High-performance fibers and composites

… high-performance fibers and composites including …

Carbon fiber composite, Aramid fiber composite, and Ultra High Molecular Weight Polyethylene Fiber (UHMWPE) are commonly considered the top three high-performance specialty fibers.

Carbon fiber composite

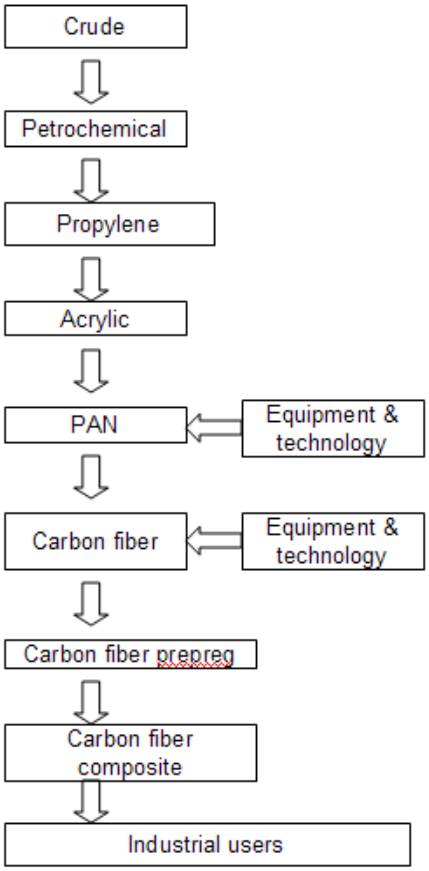
… carbon fiber composite …

Carbon fiber is used extensively for its high strength and light weight characters, e.g. airplane wings, wind power blades, and sport gears. In Jun 2010, Mr. CHEN Yanhai, a senior MIIT official expressed the government's desire to establish industry standards to promote a healthy development in the industry (expected to be announced in 2011). In addition, China may impose import restrictions on certain carbon fiber products that have domestic production capacity.

Market opportunity

Carbon fiber composite market is characterized by strong demand, high entry barrier, very limited domestic output and high margin. The demand is huge as the composite is widely used in national defense and civilian applications. On the other hand, domestic output is limited, satisfying less than 20% of China's current demand. The reason is that China's own technology is backward and cannot find overseas technology vendors until in recent years. That's why the market is dominated by foreign companies. Import reliance of carbon fiber has become a major challenge to China's other strategic industries. For example, it is a key hurdle for China's wide-body airplane program.

Chart 6.10: Value chain – carbon fiber composite



Source: BofA Merrill Lynch Global Research

... Aramid fiber composite ...

Key players along the value chain (Chart 6.10)

Bottleneck remains in Peroxyacetyl Nitrate (PAN) and carbon fiber making. The acrylic market is commoditized and has excessive capacity. In 2009, China shut down some 25% of the industry's capacity. For both PAN and carbon fiber, China needs to import the associated technology/equipment. So far, most Chinese manufacturers import PAN and produce carbon fibers. They mainly make low end products (T200-300) while mainstream products are T700-800 or higher. Many local makers were hurt by the global financial crisis as foreign suppliers tried to expand sales in China and cut their prices significantly. The carbon fiber prepreg and composite markets are already commoditized. Table 6.10 lists the main players that have an exposure to the carbon fiber sector.

Table 6.10: Exposures to carbon fiber

Company	Ticker	Market cap (USD bn)	Market share	Product type
Petrochina	601857 CH	305.2	NA	PAN
Yunnan Yuntianhua	600096 CH	2.1	N/A	PAN
Shandong Xintian	Not listed	NA	N/A	PAN
Sinopec Shanghai	600688 CH	7.3	N/A	PAN
Shanghai Synthectic Fiber Research Institute	Not listed	NA	N/A	PAN+carbon fiber
Sinosteel Jilin Carbon	000928 CH	0.6	N/A	PAN+carbon fiber
Shanghai Xinlou	Not listed	NA	N/A	carbon fiber
Ningxia Dayuan Chemical-A	600146 CH	1.1	N/A	Prepreg
Hunan Boyun New Materials	002297 CH	0.7	N/A	Composite

Source: BofA Merrill Lynch Global Research

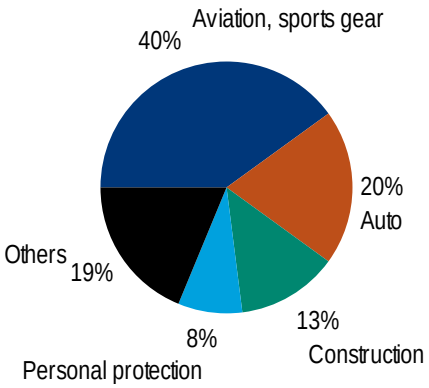
PetroChina, via its subsidiary in Gansu Province, Lanzhou Petrochemcial, is a major PAN maker in China.

Aramid fiber composite

Aramid is used extensively for personal protection, e.g. wears for fire fighters, steel smelting & casting workers and police force, because of its heat/acid-resistance, high strength and light weight characters. It's also used in many other industries including fiber optics, auto, aerospace & aviation, national defense, electronic mechanics, construction, automobile and sporting gear (Chart 6.11). Aramid has two types: PMIA (called "Aramid 1313" in China) and PPTA ("Aramid 1414"). By mid 2010, China could meet 63% of its demand for PMIA with domestic supply, but it has just started to have production capacity of PPTA.

In NDRC's "Chemical Fiber Industry Development Guideline (2006-2010)" issued in 2006, the government highlighted Aramid 1313 and 1414 as key development areas in the high-tech fiber industry.

Chart 6.11: Aramid applications (2008)

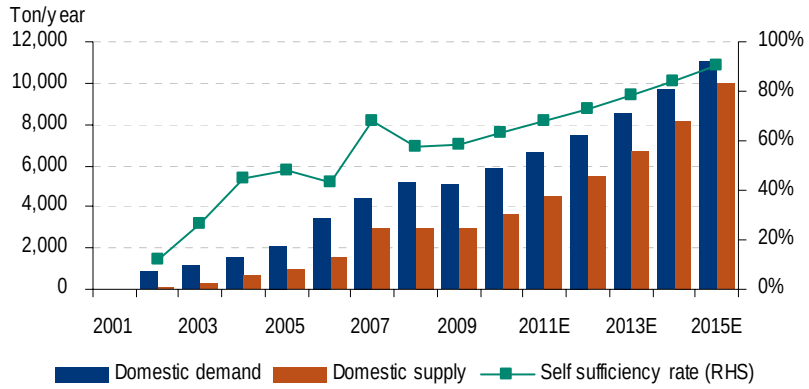


Source: Company Data, BofA Merrill Lynch Global Research

Market opportunity

The PMIA (Aramid 1313) the market is characterized by high growth, high entry barrier, limited competition and high margin (Chart 6.12). China only started to produce PMIA in early 2000's and high import price discouraged demand. In recent years, domestic makers significantly lowered PMIA prices and that has triggered a jump in demand. Ministry of Commerce (MOC) estimated that by 2015, China will be able to meet 91% of domestic demand with its own supply (Chart 6.12).

Chart 6.12: PMIA(Aramid 1313) supply & demand – China



Source: MOC, BofA Merrill Lynch Global Research

The entry barrier is high because making it is technology demanding and capital intensive (about Rmb100mn capex for 1,000 MT capacity). By 2009, only two Chinese companies managed to develop the technology to produce PMIA, both via in-house research as foreign companies refused to sell. As a result, competition is fairly limited in China, with only two domestic players (Yantai Spandex & Guangdong Caiyan, Table 6.11). Gross margin in the industry has come down over the years but still remained above 30%.

Table 6.11: Major PMIA makers ranked by capacity (2006)

Company	Production capacity (MT)	Country
DuPont	25,000	USA
Yantai Spandex	2,500	China
Teijin	2,350	Japan
Russia Terlon	1,500	Russia (production suspended)
Guangdong Caiyan	1,000	China

Source: Yantai Spandex, BofA Merrill Lynch Global Research

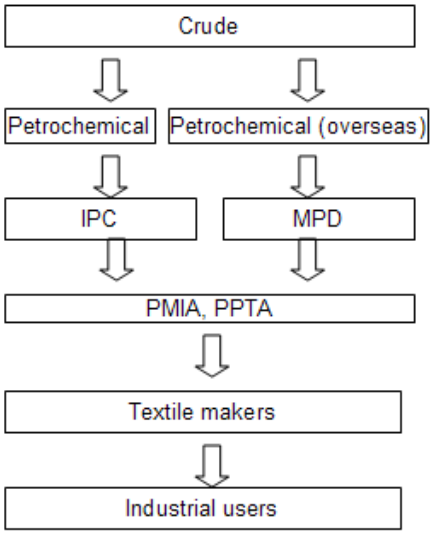
The PPTA (Aramid 1414) market has similar features as the PMIA market and domestic competition here is even less. China currently has only one maker, Changshu Zhaoda Special Fiber, which commenced production in Apr 2010. Its designed capacity is around 1.5% of the total globally. Table 6.12 shows major overseas PPTA makers.

Table 6.12: PPTA makers ranked by capacity (2006)

Company	Production capacity (MT)	Country
DuPont	33,000	USA
Teijin	24,500	Japan
Kolon	1,000	Korea (capacity will increase)
Russia	1,000	Russia
Hoechst	360	German (stop producing)

Source: Yantai Spandex, BofA Merrill Lynch Global Research

Chart 6.13: Value chain - aramid



Source: BofA Merrill Lynch Global Research

Key domestic companies exposed to Aramid

The industry value chain is shown in Chart 6.13. There is no bottleneck either upstream or downstream. Domestic companies dominate the raw material and equipment parts of the market. Domestic isophthaloyl dichloride (IPC) makers have modest bargain power, as only a few of them can produce the high quality IPC that is used to make Aramid. M-phenylenediamine (MPD) supply has also been commoditized. All the three Chinese Aramid makers (Table 6.13) build their own equipment and only purchase some non-core parts.

Table 6.13: Exposures to aramid makers

Company	Ticker	Market cap (USD bn)	Market share	Product type
Yantai Spandex Co Ltd -A	002254 CH	1.4	60%	PMIA
China Charming	Not listed	NA	24%	PMIA
Suzhou Zhaoda Special Fiber	Not listed	NA	NA	PPTA

Source: BofA Merrill Lynch Global Research

Ultra High Molecular Weight Polyethylene Fiber (UHMWPE)

High-tech fiber is a key development area in the textile industry that the government is focusing on. In its “Textile Industry Science and Technology Development Outline 2011-2015”, the government vows to strength R&D in textile fiber materials & fiber material processing, and targets 5 key technologies, including 47 sub categories, in the high-tech fiber sector for technology breakthroughs.

... and UHMWPE.

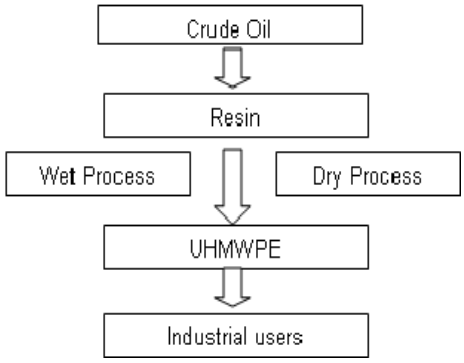
Market opportunity

Because of its strength and corrosion resistance characters, UHMWPE is widely used for military and civilian purposes, including weapons, bullet-proof vest, ropes, fishing nets and during automobile painting process. By 2010, domestic production capacity reached 6,500 MT, accounted for about half of the world’s total; and total output reached 3,000MT, mostly exported.

There are two types of production process in the world: the wet spinning method as represented by Honeywell, the world largest UHMWPE producer; and the dry spinning method as represented by DSM and Toyobo. At present, most Chinese makers use the wet spinning method and in general their technology needs to be upgraded to international level.

The dry spinning method is still immature in China. Compared to the wet method, it has a shorter process and higher product performance, and also causes less pollution. To achieve a breakthrough, Yizheng Chemical Fiber, a subsidiary of Sinopec, China Textile Academy and Nanjing Chemical Industrial Company (NCIC) researched, developed and then built the first production line using the dry method (300MT capacity) at the end of 2008.

Chart 6.14: Value chain - UHMWPE



Source: BofA Merrill Lynch Global Research

Key players along the value chain (Chart 6.14)

Crude oil is the raw material for UHMWPE. Usually a petrochemical company uses crude to make synthetic resin which is then turned into UHMWPE. Table 6.14 lists some of the major companies in China that are involved with UHMWPE production.

Table 6.14: Exposures to UPMWPE

Company	Ticker	Market cap (USD bn)	Description
Sinopec Yizheng	600871 CH	6.1	A subsidiary of Sinopec. It built the first UHMWPE production line using the dry spinning method in 2008.
Sinotex	600061 CH	0.9	Its wholly owned subsidiary, Beijing Tongyizhong Co. makes “Futai” and “Huxing” brands high performance UHMWPE products.
Ningbo Dacheng	unlisted	NA	high modulus Polyethylene (PE) fiber, bulletproof products, blade cut-resistant gloves and high tenacity ropes. Its products have been exported to more than 50 countries and regions in the world.
Hunan Zhongtai	unlisted	NA	UHMWPE, Unidirectional Fabric (UD), bulletproof vest, bulletproof & anti-stab vest, bulletproof plate, bulletproof helmet, anti-incision gloves, high strength rope and other related products.
Zhengzhou Antai	unlisted	NA	The company mainly engaged in UHMWPE research, technical consulting, production line design, and related equipment manufacturing.

Source: BofA Merrill Lynch Global Research

Generic basic materials

Generic basic materials cover ...

The State Council announcement lists nano-materials, superconducting materials and intelligent materials as key development areas.

... nano materials ...

Nano-material

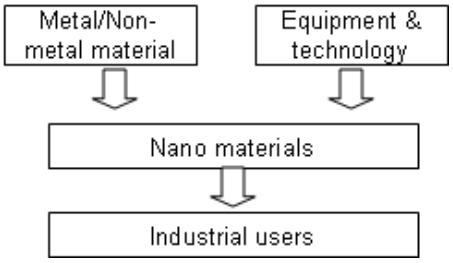
The government has shown strong support to nano research since at least the beginning of this century. Table 6.15 details some of the policies and measures that the government has implemented in recent years.

Table 6.15: Recent government policies - nano-technology

2001	The Ministry of Science and Technology (MoST), NDRC, Chinese Academy of Science (CAS) , Ministry of Education (MoE), and NSFC jointly published "National Nanotechnology Development Plan 2001-2010": 1) to focus on nano-material development and application as the major short-term goal; 2) to strengthen basic R&D on cutting-edge nanotechnology; 3) to promote nano-technology transformation, nano-material application; 4) to build a national nanotechnology R&D base; 5) to develop a high-quality nanotechnology talent pool.
2003	Supported by NDRC, National Center of Nano Science and Technology was built in Beijing, while National Engineering Research Center for Nanotechnology was built in Shanghai.
2010	National Natural Science Foundation of China (NSFC) named "Basic research on Nano-manufacturing" as one of its major research projects.

Source: BofA Merrill Lynch Global Research

Chart 6.15: Value chain – Nano-material



Source: BofA Merrill Lynch Global Research

Market opportunity

Nano-materials are widely used in military and civilian areas and are usually divided into five broad categories: functional materials (nano composite, nano plastic, nano coating, and etc.), medical materials (e.g. reagent products and those used in gene therapy, biomedical, and early diagnosis & treatment of major diseases), new energy materials (e.g. nano-crystalline chemical solar cell), environmental materials (e.g. waste water treatment and air purification through nano's adsorption features, solid waste disposal through its biodegradable features), and electronic information materials (e.g. nano–network communication devices).

Nano-materials are made from metal/non-metal materials (Chart 6.15). It's still early days for commercialization of nano technology in China and we have not been able to identify any meaningful exposure in the stock market. Advanced Technology & Materials (000969 CH), a firm established by China Iron & Steel Research Institute Group (CISRI), provides solutions to materials producers in China, including those making nano-crystalline materials.

Superconducting material

… superconducting materials …

Superconducting material is an alloy composite that shows zero-resistance characteristics under certain low temperature. It's made from 28 superconductive elements including niobium and lead, and combined with other metal/non-metal materials. In this area, China has done some cutting edge research. Like many other high-tech industries, the sector enjoys various tax benefits. The government is also trying to provide advanced facilities to conduct related R&D. For example, it set up its first superconducting material engineering laboratory in Xi'an Economic Development Zone in 2009.

Market opportunity

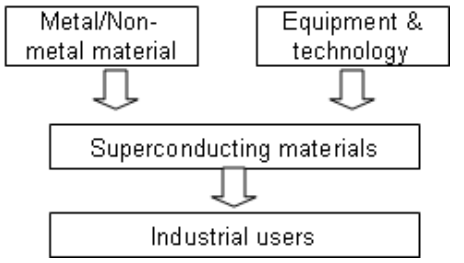
Superconducting has been used in many industries including electricity, telecommunications, national defense, aviation, transportation, and biomedical. Below is a few examples.

In the electricity sector, superconducting has been applied to Superconducting Magnetic Energy Storage (SMES), electric wire & cable, and superconducting current limiter. Take high-temperature superconducting cable (HTS) as an example, it can transmit 3-5 times more power than the conventional cable of the same size. In 2004, HTS was successfully tested in Kunming city, making China the 3rd country that put superconducting cables into use, right after the US and Demark. Besides, in 2009, there was only three companies in the world can mass produce HTS, China's InnoST was one of them (the other two were Superpower from USA and Sumitomo from Japan).

In the telecom sector, superconducting has been mainly used to produce superconducting filter system which can cut mobile transmission power, expand base station coverage, save frequency resources, reduce RF interference, and improve call quality. China is among the pioneers in this field. For example, in 2005, superconducting filter technology was successfully tested by Unicom's CDMA network in Haidian District (Beijing), covering more than 0.1mn people.

In the national defense sector, superconducting power technology and filter system are being used in areas such as minesweepers, electromagnetic weapon and high-precision superconducting gyroscope navigation. For example, SMES devices can greatly enhance naval vessels' mobility, offensive & defensive capabilities and information warfare technology.

Chart 6.16: Value chain- superconducting material



Source: BofA Merrill Lynch Global Research

Key players along the value chain (Chart 6.16)

Table 6.16 lists the key exposure to superconducting in the stock market.

Qingdao Hanhe Cable: Hanhe's 51% owned subsidiary, InnoST, is a leader in the HTS industry in China, specializing in the R&D, manufacturing and sale of HTS wires and related application products. In Oct 2001, InnoST participated in China's first high temperature superconducting cable pilot test project (30m, 35kV/2kArms, 3-phase). In July 2004, its wires were used in China's first commercial superconducting grid network. Innopower, an associate of InnoST, engages in the R&D, production and marketing of superconductive electric products and their applications.

Western Metal material: its subsidiary (32% interest), Western Superconducting Technologies Co, specializes in titanium ally based superconducting materials that are used in the fields of aviation, spaceflight, and medical treatment.

Zongyi group: Zongyi' subsidiary, SuperConductor technology Co, carries out high-temperature superconducting filter technology research, development, and implementation. In 2005, its products were successfully tested by China Unicom for its CDMA network in Beijing.

Jiangsu Etern Company: on 22 Dec 2010, it announced to invest Rmb72mn to establish Suzhou Liding New Materials Co. to focus on superconducting materials.

Hi-Tech Group: Hi-Tech's subsidiary, Hi-Tech Superconducting Electronic Technology Co., makes high-temperature superconducting film, chip, and filter subsystem.

Baosheng group: mainly focuses on wire & cable production, cable materials, and superconducting conductor materials below 500kv.

Table 6.16: Exposures to super conducting materials

Company	Ticker	Market cap (USD bn)	Market share
Western Metal	002149 CH	0.6	NA
Zongyi Group	600770 CH	2.2	NA
Jiangsu Baosheng Group	600973 CH	0.5	NA
Jiangsu Etern	600105 CH	0.9	NA
Hi-tech Group	600082 CH	0.5	NA
Hanhe Cable Co.	002498 CH	3.5	NA

Source: BofA Merrill Lynch Global Research

Intelligent material

… and intelligent materials.

The intelligent material is a composite that can sense changes in external environment and automatically alter its own properties to adapt to the changes. In nonferrous metals Industry's Mid-Long Term Development Plan (2006-2020), the government lists R&D on intelligent materials and structure technology as one of its major projects.

Market opportunity

Intelligent materials are widely used in construction, aerospace & aviation, bio-medical, telecommunication, national defense and automobile industries due to their sensing function, feedback function, information recognition & accumulation, response function, self-diagnostic capabilities, self-repair ability and adaptive ability. Some of their applications are listed below.

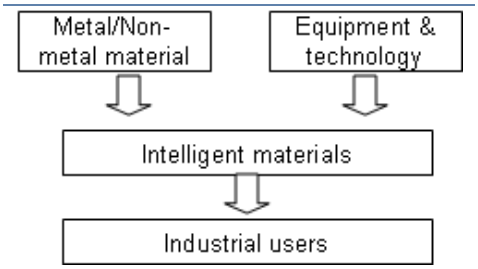
Electro-/magneto-rheological fluids (ERF& MRF): due to their fast response, continuously adjustability, and lower energy consumption features, they are the primary materials used in intelligent system and actuator in aerospace & aviation, automation equipment and petrochemical industries. It is reported that more than half of the world's hydraulic systems and devices need to be redesigned since the emergence of ERF/MRF.

Intelligent optical fiber: presently, there are mainly three for telecommunication network construction: G652, G653, and G655. Among them, G652 is used in both core network and access network while G655 has just been adopted for new lines in core network construction. Intelligent optical fiber has applications in many other areas, for example, intelligent carbon fiber, aircraft safety (metal fatigue), construction structural and safety monitoring systems.

Potential exposures

Similar as superconducting materials, upstream suppliers are metal/non-metal mining companies. Makers of intelligent materials in China include:

Chart 6.17: Value chain – intelligent material



Source: BofA Merrill Lynch Global Research

Fasten Group: It developed and makes G652 optical fibers. It also has a 50:50 JV with Pell Technology Co (USA), called Fasten Pell Material Technology Co. in Jiangyin (Jiangsu), that makes nickel-titanium memory alloys.

SDG Information: It makes optical fiber, cable, power optic cable, indoor cable, communication equipment, and electronic components.

YCIG wireless: Its main products include optic digital transmission equipment and optic fiber and cable.

Table 6.17: Exposures to intelligent materials

Company	Ticker	Market cap (USD bn)	Market share
Fasten Group	000890 CH	0.4	NA
SDG Information	000070 CH	0.4	NA
YCIG wireless	600345 CH	0.5	NA

Source: BofA Merrill Lynch Global Research

New energy cars

The government's aim is to make China a leader in making high energy efficiency and low emission cars. The State Council's announcement lists plug-in hybrid car and electric car and their associated sectors, including fuel cell, battery, motor, electric control system as key development areas (Table 7.1).

Table 7.1: New energy cars sector overview

Targeted areas	Policies	Relevant stocks
Core technologies including those in battery, electric motor and electric control system (动力电池、驱动电机和电子控制领域关键核心技术)	The government may provide subsidies and tax benefits to car makers and consumers; promote industry association and common standards; build out necessary infrastructure, e.g. charging stations and power grid.	LCO: Tibet Mineral (000762 CH), Western Mining (601168 CH), Jiangxi Special Electric Motor (002176 CH), CITIC Guoan (000839 CH), Ji En Nickel (600432 CH),Tianqi Lithium (002466 CH), Ganfeng Lithium (002460 CH), Luxiang (002192 CH) Cathode material: Thunder Sky Battery (729 HK), Easpring Material Tech (300073 CH), Ningbo Shanshan (600884 CH), Do-Fluoride Chemicals (002407 CH), Xiamen Tungsten (600549 CH),Guotai International (002091 CH), Capchem Tech (300037 CH) Separators: Foshan Plastics (000973 CH) Cells & battery pack: Tianneng (819 HK), Advanced Battery (ABAT US), China Bak Battery (CBAK US), Foshan Electrical and Lighting (000541 CH), China-Kinwa High Tech (600110 CH), EVE Energy (300014 CH), Desay Battery (000049 CH), Fengfan (600482 CH), Corun New Energy (600478 CH), Kingray New Materials (600390 CH), Jonjee Hi-Tech (600872 CH), Xiamen Faratronic (600563 CH) Motor: Broad-Ocean Motor (002249 CH), Senyuan Electric (002358 CH) Charging station: China Titans Energy (2188 HK), Auto Electric Power (002227 CH), Clou Electronics (002121 CH), Zhongheng Electric (002364 CH) Electric cars: BYD (1211 HK) Power grid equipment: Sieyuan Electric (002028 CH), NARI Tech (600406 CH), Dynamic Power (600405 CH), XJ Electric (000400 CH), Guodian Nanjing Automation (600268 CH), Rongxin Electronic (002123 CH)
Plug-in hybrid car, electric car (插电式混合动力汽车、纯电动汽车)		
Fuel cell (燃料电池汽车相关前沿技术研发)		

Source: BofA Merrill Lynch Global Research

Market opportunity

Electric car cuts emissions and is cheaper to run.

When we talk about new energy cars in this report, we are largely referring to electric cars.

Compared to traditional cars, the advantages of electric cars include 1) they can cut emissions, including CO2, CO, SO2, and nitrogen oxides, significantly; 2) they have higher energy efficiency, at ~90% vs. ~20% of traditional cars. From consumers' perspective, they are also much cheaper to run. For example, a typical 1.6L car burns ~7L gasoline to run 100km, costing ~RMB46 at the moment (~Rmb6.6/L for #93). On the other hand, a typical electric car needs 15KWH electricity to run 100 the same length, only costing Rmb9 at Rmb0.6/KWH.

But at this stage it's inconvenient to use and costs more to buy.

The most common complaints about electric cars are inconvenience (i.e. lack of charging stations and slow charging speed) and purchase price. Shenzhen Taxi divers told us that it currently takes them about 2 hours to fully charge the car, or

half an hour for an half charge. In addition, the network of charging stations is small. An electric car can run 150-300km after a full charge. While enough for inter city driving, it may present a problem for longer distance traveling. Moreover, like-for-like, electric cars are often much more expensive. For example, Toyota Camry 2.4L costs Rmb226,800 - 255,800 per car, but equivalent hybrid models are sold at RMB319,800 - 364,800 a car, ~40% more expensive.

Other than for car enthusiasts, the performance of electric cars appears adequate (Table 7.2).

Table 7.2: Electric cars - performance comparison

Maker	Model	Engine power (Kw)	Top speed (Km/h)	Shortest time taken for 80% power charge (minutes)	Regular time taken for full power charge (hours)	Drive distance per change (Km)	Notes
BYD	E6		140	15		300	
Chery	S18	40		30	4-6	150	
Chang'an	MINI		130			180	
Geely	Panda	84		40	5	180	
Nissan	Leaf	80	140			200	
BMW	MINIE	204				200	Takes 8.5seconds to reach speed of 100Km/h
Audi	E-tron	204	200			249	Takes 5.9 seconds to reach speed of 100Km/h

Source: BofA Merrill Lynch Global Research

Table 7.3 summarizes the key differences between traditional cars and electric cars.

Table 7.3: Comparison between conventional cars and electric cars

	Conventional	Hybrid	Electric
Energy efficiency	Low	Medium	High
Emission	High	Medium	Low
Car price	Low	High	High
Energy cost per mile	High	Medium	Low
Maintenance cost	Low	High	High
Refueling (charging) convenience	Convenient	Convenient	Inconvenient
Refueling (charging) infrastructure	Good	Good	Poor
Power	High	Medium	Low
Weight	Light	Medium	Heavy
Travel distance (KM)	>400	>500	<300

Source: BofA Merrill Lynch Global Research

Government policies

The government has set ambitious targets for electric cars. As part of the stimulus package to counter the financial crisis, the government's "Auto Industry Revival Plan" announced in March 2009 called for 500,000 unit new energy auto manufacturing capacity by 2011; new energy auto as % of total auto sales to reach 5% by 2011; and 1bn Ah high performance battery manufacturing capacity within 3 years. In addition, according to China News quoting MIIT, SIC and China Auto Industry Association, the government's focus for the auto industry during the 12th Five-Year Plan period (2011-2015) will shift from building the scale to improving quality, including promoting new energy cars (with electric cars at the core) and reducing redundant capacities through industry consolidation.

The government favors electric car and hybrid cars with an electric plug.

On Jun 1, 2010, the government announced an aggressive scheme to subsidize new energy car purchases in 5 pilot test cities (Shanghai, Shenzhen, Changchun, Hangzhou, and Hefei):

- Energy efficient cars (<=1.6L, ~20% energy saving vs. an ordinary car), including hybrid cars (HEV) are entitled to Rmb3,000/car subsidy.
- Hybrid cars that have an electric plug (PHEV) and meet curtain requirements are entitled to Rmb3,000/KW/car subsidy, up to RMB50,000/car.
- Pure electric cars (EV) are entitled to Rmb3,000/KW/car subsidy, up to RMB60,000/car.
- The subsidies will be "appropriately" reduced after a car maker reaches 50,000 units accumulated sales (each category is counted separately).

Overall, it seems that the government favors EV & PHEV as subsidy to HEV is much less generous.

“Subsidies” can come in different forms. For example, local governments are asked to build the charging stations and related infrastructure (By the way, we have heard some complaints from the local governments that they can't afford to pay for the massive rollout of charging stations and are hoping for financial support from the central government). Separately, sixteen centrally controlled SOEs, including the First Auto Works, Dongfeng Auto, Changan Auto, National Grid, Southern Grid, PetroChina, Sinopec, CNOOC and China Poly, formed Electric Car Industry Association in August 2010. The aim of the association is to come up with industry standard, develop core technologies for the industry and build internationally competitive auto makers and brands.

In our view, the government plays a critical role for the industry, especially at the early stage of its development when cashflow throughout the value chain is heavily negative. Some weak links, e.g. infrastructure, require either government funding or preferential policies to get private capital in.

Blue sky potential

Sky is the limit if the industry works.

The size of the electric car market in China a few years out will be largely determined by the following factors in our opinion:

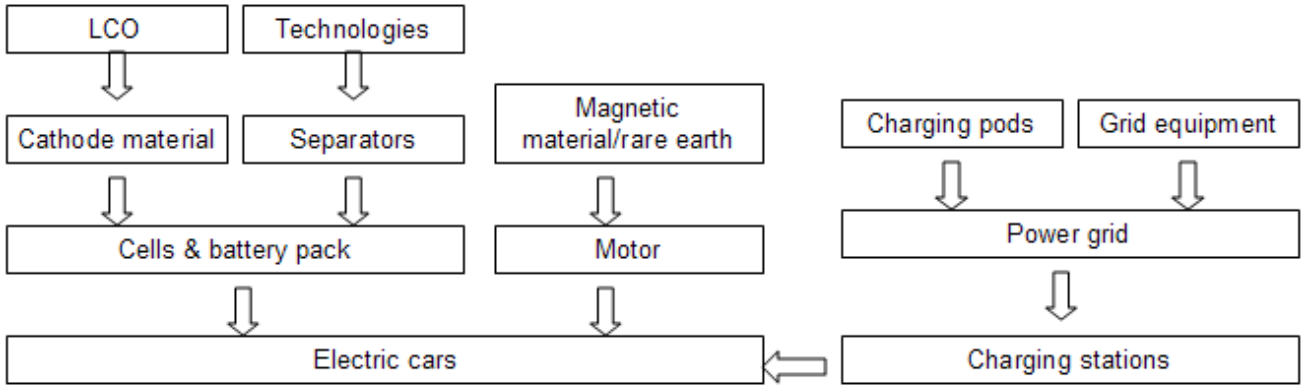
- Government commitment holds the key. That will determine how much subsidy the government is willing to provide in order to jump start the market; how much help it will offer to ramp up the infrastructure (charging stations);
- Will taxes be imposed on ordinary cars to help electric cars?
- Other important factors such as oil price, cost of batteries, and people's environmental awareness.

According to A.T. Kearney's estimates, electric cars (HEV, PHEV & EV) will have a 17% market share globally by 2020, or some 13mn cars. We will be surprised if the ratio in China is much lower in China by then given the electric car industry has all the hallmarks of the type of things that the Chinese government is good at, i.e. concentrating national resources to achieve something big.

Key players along the value chain

The value chain of the electric car industry is long, including battery makers, motor makers, car makers, and charging infrastructure.

Chart 7.1: Value chain – electric cars



Source: BofA Merrill Lynch Global Research

Charging station is probably the most immediate beneficiary.

Charging station: an immediate beneficiary

The most immediate beneficiary of the electric car industry is equipment vendors for the charging network. Before electric cars can gain mass market acceptance, a convenient infrastructure has to be put in place (Exhibit 7.1). Players here include Auto Electric Power (002227 CH) and Clou Electronics (Clou Electronics).

Exhibit 7.1: Charging stations

Source: BofA Merrill Lynch Global Research

Some materials and parts suppliers to the industry will also benefit.

Magnetic materials/rare earth/motor maker to benefit

There are mainly three kinds of motors used on electric cars: i.e. permanent magnet synchronous motor (PMSM), 3-Phase AC Induction Motor, and switched reluctance motor (SRM). The first two are most important.

- 3-phase AC induction motor is chosen by many car makers. It's mature, cheap, reliable and stable.
- Permanent magnet synchronous motor (PMSM) seems to be the ideal high performance motor for electric cars. It's highly efficient and reliable. Many electric car makers use PMSM including Toyota, Honda, and many Chinese car makers.

Broad-Ocean Motor (002249 CH) is a listed motor vendor proactively investing in electric car motors. Electric car motors will drive demand for permanent magnetic materials (more in the rare earth section).

Lithium battery: the most expensive part in the car

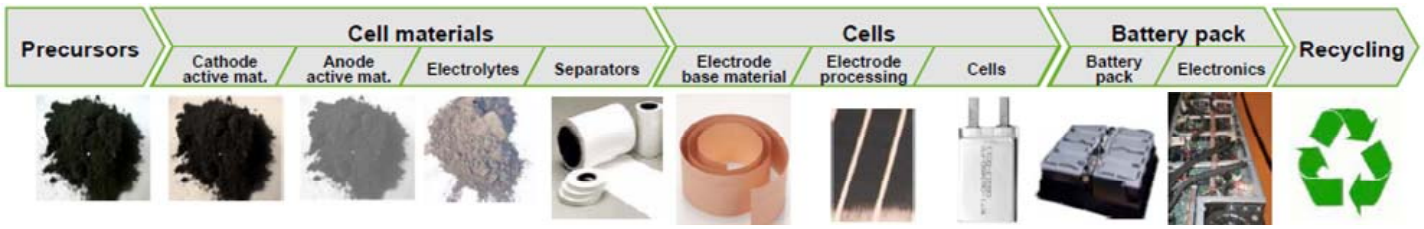
Lithium battery is the most important/expensive part of an electric car. Table 7.4 contains a list of major battery makers in the world. Overtime, battery prices need to fall to make electric cars more affordable via efficiency gains, economy of scale and technology advancement. The entry barrier in the high performance battery space is very high.

Table 7.4: Battery manufacturer competitive landscape

Company	Chemistry	HQ	Factory Location(s)	Announced Partners	Announced Customers
A123 Systems	LFP	US	US, China, Korea	GE	Fiat, Chrysler, BMW, SAIC
AESC (NEC)	LMO	Japan	Japan	Nissan	Nissan, Subaru
BYD	LFP	China	China		BYD
EnerDel	LTO / LMO	US	US, Korea	ITOCHU	Th!nk, Fisker, Volvo
GS YUASA	NiMH (HEVs) / LMO	Japan	Japan	Mitsubishi Motor	Mitsubishi, Honda
Johnson Controls-Saft	NCA	US	US, Europe		BMW, Mercedes, Ford, Azure Dynamics, Jaguar/Land Rover
LG Chem	LMO	Korea	Korea	Compact Power	GM, Hyundai
Li-Tec (Daimler)	LCO	Germany	Germany		Daimler
Panasonic EV	NiMH (HEVs) / LCO	Japan	Japan	Toyota	Toyota
Samsung	LMO	Korea	Korea	Bosch	BMW
Sanyo	NiMH (HEVs) / LMO	Japan	Japan	Continental	VW, Porsche, Audi, Ford, Toyota

Source: BofA Merrill Lynch Global Research, Companies

Exhibit 7.2: Lithium-ion battery manufacturing process



Source: A.T.Kearney

Table 7.5: Lithium battery materials and cost breakdown

Parts	As % of cost	Materials
Cathode material	40-45%	LMO (lithium manganese oxide), LFP (lithium iron phosphate), LTO (lithium titanium oxide), LCO (lithium cobalt oxide)
Anode material	10-15%	Graphite
Electrolyte	~5%	EC, PC, DEC
Separators	~30%	PE, PP, PP/PE/PP
Casing		Aluminum, steel

Source: BofA Merrill Lynch Global Research

Cathode material is the most important material for lithium-ion batteries, making up almost half of the cost. Other important materials include anode materials, electrolyte, and separators (Exhibit 7.2 & Table 7.5).

Cathode materials include LMO (lithium manganese oxide), LFP (lithium iron phosphate), LTO (lithium titanium oxide) and LCO (lithium cobalt oxide). Key considerations when choosing cathode materials are energy density, power, safety, useful life, and price.

LCO remains the most important cathode material, with a dominant market share. But its share has been declining rapidly due to its volatile price and thermal stability issue. Alternative materials are thriving, e.g. LMO which is cheaper and has better thermal stability.

Domestic cathode material vendors are relatively small in size and mainly focus on the mid-low end market. Key players include Easpring Material Tech (300073 CH), Ningbo Shanshan (600884 CH), CITIC Guoan (000839 CH) and Xiamen Tungsten (600549 CH). Easpring Material Tech focuses on LCO; Ningbo Shanshan, LMO; CITIC Guoan, and Xiamen Tungsten have exposure to both.

For separator, pls refer to “New material – high performance membrane” for details.

Car makers: significant long term opportunities

Electric car may provide the Chinese car makers with an opportunity to leapfrog foreign competitors.

Chinese companies are significantly behind foreign automakers in making conventional cars. For example, many domestic car makers still rely on foreign partners for engines. Electric car may provide a more even play field.

Key electric car markers in China include BYD (Bin Wang, Concerns over subsidy removal vanish; reiterate Buy, Dec 19), FAW, Shanghai Auto, Dongfeng, Changan, Chery and Foton.

Companies exposed to electric cars

Table 7.6: Exposures to electric vehicle players

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
1211 HK	BYD	12.0	Car maker	High	A battery and electric car maker. Potential lithium mining in Tibet.
819 HK	Tianneng	0.5	Batteries for electric bicycle	High	Batteries for electric bicycle.
2188 HK	China Titans Energy	0.1	Charging station	Medium	Electrical DC products series, power grid monitoring and management products, charging equipment for electric vehicles, and wind and solar power generation control products.
729 HK	Thunder Sky Battery	0.7	Ion Lithium Materials	High	It provides Ion lithium materials and power battery technologies.
ABAT US	Advanced Battery	0.3	Lithium-ion batteries	Low	A lithium battery producer. Products include rechargeable batteries for mine-use lamps, electric automobiles, motorcycles, cellular phones, notebook computers, and other personal electronic devices.
CBAK US	China Bak Battery	0.1	Lithium-ion batteries	Low	A lithium battery producer. Products include rechargeable batteries for mobile phones and various other portable electronic applications, including laptop computers, digital cameras, and video camcorders. The company does not produce electric car batteries.
000541 CH	Foshan Electrical and Lighting	2.2	Lithium, battery, electric bus	Medium	China's largest lighting product producer, producing a wide range of lighting products. Currently 99% of its revenues come from lighting products. The company recently announced to enter the electric car and lithium battery industry. The company has 38% stake in a lithium carbonate JV, Qinhai Fozhao Lithium. Fozhao Lithium formed a 51:49 JV with Qinhai Salt Lake Group to explore the latter's lithium resources. The company plans to acquire 20% stake in Hefei Guoxuan High-tech, a lithium-ion battery cathode material and lithium-ion battery vendor. The company also invested in an electric auto JV, which recently announced to test its first electric bus.
002466 CH	Tianqi Lithium	0.8	Lithium carbonate	High	A lithium carbonate vendor. Battery grade lithium carbonate contributed to ~53% of its 1H2010 revenue.
002460 CH	Ganfeng Lithium	0.7	Lithium & lithium carbonate	High	A vertically integrated lithium vendor. 1H2010 revenue breakdown: lithium 41%, lithium carbonate 26%.
002192 CH	Luxiang	0.5	Lithium carbonate	Medium	An asphalt producer. It recently announced to expand its lithium business. Its lithium subsidiary is expected to have 20,000 ton/annum lithium carbonate production capacity.
000762 CH	Tibet Mineral	1.6	Lithium mining	Medium	Revenue breakdown: chromium 70%, copper 16.19% and lithium 7.54%. It can potentially become a large lithium producer.
601168 CH	Western Mining	6.8	Lithium mining	Low	A non-ferrous ore miner/trader. 1H2010 revenue breakdown: trade 59%, copper 14.4%, zinc 9.4%, aluminum 7.6%, lead 4.4%. The company has lithium reserves of ~90,000 tons.
002176 CH	Jiangxi Special Electric Motor	0.5	Lithium mining	Medium	A special motor vendor that may enter the lithium business. It's the only listed company of Jiangxi Yichun County. Yichun has China's largest tantalum-niobium ore mine, its lithia reserve is 31% of China's total.
000839 CH	CITIC Guoan	2.9	Lithium mining, battery materials	Medium	A lithium battery cathode materials vendor. 40% share in domestic lithium cobalt oxide market. The first domestic firm that commercially produced lithium manganese and lithium nickel. The company is traditionally a tech company, with 20mn+ CABLE TV subscribers. The company also produces potash fertilizer, with prospect capacity of ~1mn tons per annum. 2009 revenue breakdown: cable 41%, salt lake products 52%. Profits breakdown: IT services 23%, salt lake products 70%.
002091 CH	Guotai International	1.2	Lithium-ion battery electrolyte	High	A trading company focusing on textile, garments, electrical, light industry products, and chemicals. But lithium-ion battery electrolyte may soon become a major earnings driver. Guotai Ronghua, a subsidiary of the company, is a lithium-ion battery electrolyte producer in China.
300037 CH	Capchem Tech	0.7	Lithium-ion battery electrolyte	High	It specializes in lithium-ion battery electrolyte. 1H2010 revenue breakdown: super capacitor electrolyte 70%, lithium-ion battery electrolyte 30%.
300073 CH	Easpring Material Tech	0.6	Lithium cathode materials	High	A lithium cathode materials producer and its main product is lithium cobalt oxide.
600884 CH	Ningbo Shanshan	1.6	Various battery materials	High	The company is a leading lithium-ion battery materials vendor, with 36% of its revenue coming from such products. It's has a domestic garment brand, with 62% of its revenue coming from the segment. The company has a 20% stake in an associate company which makes single crystal silicon films from scraps.
000973 CH	Foshan Plastics	1.4	Membrane separators	Medium	The company's main product is plastic membrane and other plastic products. The company has a JV with BYD producing film for lithium batteries. Currently, it only produces separators for traditional lithium batteries and its separators for electric car lithium batteries are still at the R&D stage.
002407 CH	Do-Fluoride Chemicals	1.3	Lithium hexafluorophosphate	Medium	The world's largest inorganic fluoride chemicals producer. Revenue breakdown: aluminum fluoride 48%, cryolite 47%; both products are mainly used in aluminum smelting. The company also produces lithium hexafluorophosphate, which is used in lithium batteries. Currently, lithium hexafluorophosphate production is still at the early stage, but it can potentially become an important earning driver.
600110 CH	China-Kinwa High Tech	1.4	Copper toils for lithium battery	Low	Currently main revenue source is electrical cables but it makes most of its profit from its oil field assets. The company invested in an electric material production base in Qinghai province, producing copper toils, PCBs, and lithium battery materials. Copper toils are mainly used in PCBs; high-end copper toils are used in lithium batteries.

Table 7.6: Exposures to electric vehicle players

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
300014 CH	EVE Energy	0.5	Lithium battery maker	Low	The largest lithium battery maker in China. Main products are lithium primary battery and rechargeable battery. 39% domestic market share in 2008. So far the company has no presence in electric car batteries.
000049 CH	Desay Battery	0.5	Battery maker	Low	A battery maker, a mobile power solutions provider. It has some exposure to electric car battery through its associate company, YiNeng Electric.
600482 CH	Fengfan	1.1	Battery maker	Low	A battery maker. Main product is lead-acid storage battery (for auto), which contributed to ~90% of its 1H10 revenue. The company is expanding into lithium battery, currently mainly for digital camera and lap tops. Electric car lithium-ion battery is still at the research stage. The company also produces solar cells, which is still at very early stage. The company has a gold mine, with estimated total reserves of gold 10.2 tons, silver 1550tons, zinc and lead 870,000 tons.
600478 CH	Corun New Energy	0.8	Ni-MH battery	Medium	The world's largest nickel foam (battery material) producer. The company has a JV focusing on electric car ni-mh battery, designed capacity 20,000units/annum. Currently the company is testing the product with car makers.
600390 CH	Kingray New Materials	0.5	Ni-MH battery	Medium	A base materials vendor for the electronic industry. 1H10 Revenue breakdown: manganese 35%, manganese oxide 21%, magnetic core 16%, nickel hydroxide 27%. The company has a 40% share in domestic nickel hydroxide market, used to supply to BYD & Yuasa (Japan), is now expanding to American and European markets with its new product-cover cobalt oxidized nickel hydroxide. Its parenco, Changsha Research Institute Of Mining And Metallurgy, was recently merged into Minmetals (a large state owned metals conglomerate).
600872 CH	Jonjee Hi-Tech	0.9	Ni-MH battery	Medium	A conglomerate (property, seasoning product, leasing, battery) with Ni-MH battery exposure. It received Rmb9mn R&D grant in 2006 for battery research. Its battery products served Beijing Olympics (electric cars). The company currently has battery production capacity of 20mn Ah.
600432 CH	Ji En Nickel	3.1	Nickel	Low	The largest nickel producer in China. Nickel is mainly used to produce stainless steel. Ni-MH battery may drive demand for nickel.
600549 CH	Xiamen Tungsten	4.9	Tungsten, rare earth, cathode materials	Medium	The world's largest tungsten producer. The company has a fast growing new energy segment, contributing to 21% of its 1H10 revenues. Main products are hydrogen storage alloy powder and lithium cathode materials.
002249 CH	Broad-Ocean Motor	2.0	Motor	Medium	A motor vendor, investing in electric car motors. It has 5,000/annum Permanent magnet synchronous motor (PMSM) capacity. Currently its main product is air conditioner motor, which represented 84% of its 1H10 revenues.
002227 CH	Auto Electric Power	0.5	Charging station	High	A power supply equipment vendor. Main product is high frequency switching dc power supply system, which contributed to ~80% of its 1H10 revenues. The company is the only qualified domestic power supply system vendor to the nuclear power plants. Charging station may potentially become the largest earnings driver in the future. The company & BYD were both chosen to build charging stations in Shenzhen on a pilot test basis.
002121 CH	Clou Electronics	1.2	Charging station	Low	A power distribution equipment vendor, a smart (electricity) meter vendor. One of the few domestic firms that have high-current fast charge (charging station) technology. Frequency converter business was set up in 2008.
002028 CH	Sieyuan Electric	1.8	Power grid equipment	Low	A power grid equipment vendor. Main products include high voltage switchgear, power system protection equipment, and high-voltage transformer.
600406 CH	NARI Tech	5.7	Power grid equipment	Low	A power grid equipment vendor. Main products include substation automation, electric network management automation, and metro electric automatic/protection system.
600405 CH	Dynamic Power	0.4	Power grid equipment	Medium	A power grid equipment vendor. Main products include DC power supply system, AC power supply system, high voltage inverter, and monitoring system. The company has done research on batteries and high performance charging equipments.
000400 CH	XJ Electric	1.9	Power grid equipment	Low	A power grid equipment vendor. Main products include transfers, plant protection and automation, power grid dispatching, substation automation, and distribution system automation. The company plans to acquire a controlling stake of Xuji Power Supply Equipment, a sister company, from its parent. The latter has footprints in charging stations, but the business is still at the early stage.
002364 CH	Zhongheng Electric	0.3	Charging station	Low	A power supply system vendor. 71% of its 1H10 revenue came from power supply products for the communications industry. The company participated in charging station design and construction in Hangzhou.
002358 CH	Senyuan Electric	0.6	Switchgear	Low	A switchgear vendor.
600268 CH	Guodian Nanjing Automation	1.3	Power grid equipment	Low	A power automation equipment vendor. Main products include power grid protection and automation, power plant protection and automation, industrial automation, and hydropower automation. The company set up a new energy subsidiary with wind power control system, solar power inverter boosters, nuclear power auxiliary products, frequency converters, and vacuum cleaner as main products. The company also has a 30% in a desulfuration (activated carbon) company, which may be ready for separate listing.

Table 7.6: Exposures to electric vehicle players

Ticker	Short name	Market cap (USD bn)	Business	Exposure	More details
002123 CH	Rongxin Electronic	2.4	Power grid equipment	Low	A energy saving power electronics equipment vendor. 2009 Revenue breakdown: power quality management products 65% (SVC ~52%), variable frequency products 17%, residual heat/pressure power generating system 13%. The company's solar power converter has begun to contribute to revenue; wind power converter is still at the test stage. Static Var Compensator (SVC), the company's most important product, is used to improve power grid quality and reduce energy consumption.
600563 CH	Xiamen Faratronic	0.9	Capacitor	Low	An electronics company. China's largest film capacitor producer. Super capacitor is the ideal capacitor for electric cars. Currently, there is no super capacitor producer in China. The company is currently supplying film capacitors to BYD, but the revenue contribution is tiny.

Source: BofA Merrill Lynch Global Research

Link to Definitions

Macro

Click here for definitions of commonly used terms.

Analyst Certification

I, David Cui, hereby certify that the views expressed in this research report accurately reflect my personal views about the subject securities and issuers. I also certify that no part of my compensation was, is, or will be, directly or indirectly, related to the specific recommendations or view expressed in this research report.

Important Disclosures

FUNDAMENTAL EQUITY OPINION KEY: Opinions include a Volatility Risk Rating, an Investment Rating and an Income Rating. *VOLATILITY RISK RATINGS*, indicators of potential price fluctuation, are: A - Low, B - Medium and C - High. *INVESTMENT RATINGS* reflect the analyst's assessment of a stock's: (i) absolute total return potential and (ii) attractiveness for investment relative to other stocks within its *Coverage Cluster* (defined below). There are three investment ratings: 1 - Buy stocks are expected to have a total return of at least 10% and are the most attractive stocks in the coverage cluster; 2 - Neutral stocks are expected to remain flat or increase in value and are less attractive than Buy rated stocks and 3 - Underperform stocks are the least attractive stocks in a coverage cluster. Analysts assign investment ratings considering, among other things, the 0-12 month total return expectation for a stock and the firm's guidelines for ratings dispersions (shown in the table below). The current price objective for a stock should be referenced to better understand the total return expectation at any given time. The price objective reflects the analyst's view of the potential price appreciation (depreciation).

Investment rating	Total return expectation (within 12-month period of date of initial rating)	Ratings dispersion guidelines for coverage cluster*
Buy	≥ 10%	≤ 70%
Neutral	≥ 0%	≤ 30%
Underperform	N/A	≥ 20%

* Ratings dispersions may vary from time to time where BofA Merrill Lynch Research believes it better reflects the investment prospects of stocks in a Coverage Cluster.

INCOME RATINGS, indicators of potential cash dividends, are: 7 - same/higher (dividend considered to be secure), 8 - same/lower (dividend not considered to be secure) and 9 - pays no cash dividend. *Coverage Cluster* is comprised of stocks covered by a single analyst or two or more analysts sharing a common industry, sector, region or other classification(s). A stock's coverage cluster is included in the most recent BofA Merrill Lynch Comment referencing the stock.

Due to the nature of strategic analysis, the issuers or securities recommended or discussed in this report are not continuously followed. Accordingly, investors must regard this report as providing stand-alone analysis and should not expect continuing analysis or additional reports relating to such issuers and/or securities.

Other Important Disclosures

Officers of MLPF&S or one or more of its affiliates (other than research analysts) may have a financial interest in securities of the issuer(s) or in related investments.

BofA Merrill Lynch Global Research policies relating to conflicts of interest are described at http://www.ml.com/media/43347.pdf.

"BofA Merrill Lynch" includes Merrill Lynch, Pierce, Fenner & Smith Incorporated ("MLPF&S") and its affiliates. Investors should contact their BofA Merrill Lynch representative or Merrill Lynch Global Wealth Management financial advisor if they have questions concerning this report.

Information relating to Non-US affiliates of BofA Merrill Lynch and Distribution of Affiliate Research Reports:

MLPF&S distributes, or may in the future distribute, research reports of the following non-US affiliates in the US (short name: legal name): Merrill Lynch (France): Merrill Lynch Capital Markets (France) SAS; Merrill Lynch (Frankfurt): Merrill Lynch International Bank Ltd., Frankfurt Branch; Merrill Lynch (South Africa): Merrill Lynch South Africa (Pty) Ltd.; Merrill Lynch (Milan): Merrill Lynch International Bank Limited; MLI (UK): Merrill Lynch International; Merrill Lynch (Australia): Merrill Lynch Equities (Australia) Limited; Merrill Lynch (Hong Kong): Merrill Lynch (Asia Pacific) Limited; Merrill Lynch (Singapore): Merrill Lynch (Singapore) Pte Ltd.; Merrill Lynch (Canada): Merrill Lynch Canada Inc; Merrill Lynch (Mexico): Merrill Lynch Mexico, SA de CV, Casa de Bolsa; Merrill Lynch (Argentina): Merrill Lynch Argentina SA; Merrill Lynch (Japan): Merrill Lynch Japan Securities Co., Ltd.; Merrill Lynch (Seoul): Merrill Lynch International Incorporated (Seoul Branch); Merrill Lynch (Taiwan): Merrill Lynch Securities (Taiwan) Ltd.; DSP Merrill Lynch (India): DSP Merrill Lynch Limited; PT Merrill Lynch (Indonesia): PT Merrill Lynch Indonesia; Merrill Lynch (Israel): Merrill Lynch Israel Limited; Merrill Lynch (Russia): Merrill Lynch CIS Limited, Moscow; Merrill Lynch (Turkey): Merrill Lynch Yatirim Bankasi A.S.; Merrill Lynch (Dubai): Merrill Lynch International, Dubai Branch; MLPF&S (Zürich rep. office): MLPF&S Incorporated Zürich representative office; Merrill Lynch (Spain): Merrill Lynch Capital Markets Espana, S.A.S.V.; Merrill Lynch (Brazil): Banco Merrill Lynch de Investimentos S.A.

This research report has been approved for publication and is distributed in the United Kingdom to professional clients and eligible counterparties (as each is defined in the rules of the Financial Services Authority) by Merrill Lynch International and Banc of America Securities Limited (BASL), which are authorized and regulated by the Financial Services Authority and has been approved for publication and is distributed in the United Kingdom to retail clients (as defined in the rules of the Financial Services Authority) by Merrill Lynch International Bank Limited, London Branch, which is authorized by the Central Bank of Ireland and is subject to limited regulation by the Financial Services Authority – details about the extent of its regulation by the Financial Services Authority are available from it on request; has been considered and distributed in Japan by Merrill Lynch Japan Securities Co., Ltd., a registered securities dealer under the Securities and Exchange Law in Japan; is distributed in Hong Kong by Merrill Lynch (Asia Pacific) Limited, which is regulated by the Hong Kong SFC and the Hong Kong Monetary Authority; is issued and distributed in Taiwan by Merrill Lynch Securities (Taiwan) Ltd.; is issued and distributed in India by DSP Merrill Lynch Limited; and is issued and distributed in Singapore by Merrill Lynch International Bank Limited (Merchant Bank) and Merrill Lynch (Singapore) Pte Ltd. (Company Registration No.'s F 06872E and 198602883D respectively) and Bank of America Singapore Limited (Merchant Bank). Merrill Lynch International Bank Limited (Merchant Bank) and Merrill Lynch (Singapore) Pte Ltd. are regulated by the Monetary Authority of Singapore. Merrill Lynch Equities (Australia) Limited (ABN 65 006 276 795), AFS License 235132 provides this report in Australia in accordance with section 911B of the Corporations Act 2001 and neither it nor any of its affiliates involved in preparing this research report is an Authorised Deposit-Taking Institution under the Banking Act 1959 nor regulated by the Australian Prudential Regulation Authority. No approval is required for publication or distribution of this report in Brazil. Merrill Lynch (Dubai) is authorized and regulated by the Dubai Financial Services Authority (DFSA). Research reports prepared and issued by Merrill Lynch (Dubai) are prepared and issued in accordance with the requirements of the DFSA conduct of business rules.

Merrill Lynch (Frankfurt) distributes this report in Germany. Merrill Lynch (Frankfurt) is regulated by BaFin.

This research report has been prepared and issued by MLPF&S and/or one or more of its non-US affiliates. MLPF&S is the distributor of this research report in the US and accepts full responsibility for research reports of its non-US affiliates distributed to MLPF&S clients in the US. Any US person receiving this research report and wishing to effect any transaction in any security discussed in the report should do so through MLPF&S and not such foreign affiliates.

General Investment Related Disclosures:

This research report provides general information only. Neither the information nor any opinion expressed constitutes an offer or an invitation to make an offer, to buy or sell any securities or other financial instrument or any derivative related to such securities or instruments (e.g., options, futures, warrants, and contracts for differences). This report is not intended to provide personal investment advice and it does not take into account the specific investment objectives, financial situation and the particular needs of any specific person. Investors should seek financial advice regarding the appropriateness of investing in financial instruments and implementing investment strategies discussed or recommended in this report and should understand that statements regarding future prospects may not be realized. Any decision to purchase or subscribe for securities in any offering must be based solely on existing public information on such security or the information in the prospectus or other offering document issued in connection with such offering, and not on this report.

Securities and other financial instruments discussed in this report, or recommended, offered or sold by Merrill Lynch, are not insured by the Federal Deposit Insurance Corporation and are not deposits or other obligations of any insured depository institution (including, Bank of America, N.A.). Investments in general and, derivatives, in particular, involve numerous risks, including, among others, market risk, counterparty default risk and liquidity risk. No security, financial instrument or derivative is suitable for all investors. In some cases, securities and other financial instruments may be difficult to value or sell and reliable information about the value or risks related to the security or financial instrument may be difficult to obtain. Investors should note that income from such securities and other financial instruments, if any, may fluctuate and that price or value of such securities and instruments may rise or fall and, in some cases, investors may lose their entire principal investment. Past performance is not necessarily a guide to future performance. Levels and basis for taxation may change.

This report may contain a short-term trading idea or recommendation, which highlights a specific near-term catalyst or event impacting the company or the market that is anticipated to have a short-term price impact on the equity securities of the company. Short-term trading ideas and recommendations are different from and do not affect a stock's fundamental equity rating, which reflects both a longer term total return expectation and attractiveness for investment relative to other stocks within its Coverage Cluster. Short-term trading ideas and recommendations may be more or less positive than a stock's fundamental equity rating.

BofA Merrill Lynch is aware that the implementation of the ideas expressed in this report may depend upon an investor's ability to "short" securities or other financial instruments and that such action may be limited by regulations prohibiting or restricting "shortselling" in many jurisdictions. Investors are urged to seek advice regarding the applicability of such regulations prior to executing any short idea contained in this report.

Foreign currency rates of exchange may adversely affect the value, price or income of any security or financial instrument mentioned in this report. Investors in such securities and instruments, including ADRs, effectively assume currency risk.

UK Readers: The protections provided by the U.K. regulatory regime, including the Financial Services Scheme, do not apply in general to business coordinated by BofA Merrill Lynch entities located outside of the United Kingdom. BofA Merrill Lynch Global Research policies relating to conflicts of interest are described at http://www.ml.com/media/43347.pdf.

Officers of MLPF&S or one or more of its affiliates (other than research analysts) may have a financial interest in securities of the issuer(s) or in related investments.

MLPF&S or one of its affiliates is a regular issuer of traded financial instruments linked to securities that may have been recommended in this report. MLPF&S or one of its affiliates may, at any time, hold a trading position (long or short) in the securities and financial instruments discussed in this report.

BofA Merrill Lynch, through business units other than BofA Merrill Lynch Global Research, may have issued and may in the future issue trading ideas or recommendations that are inconsistent with, and reach different conclusions from, the information presented in this report. Such ideas or recommendations reflect the different time frames, assumptions, views and analytical methods of the persons who prepared them, and BofA Merrill Lynch is under no obligation to ensure that such other trading ideas or recommendations are brought to the attention of any recipient of this report.

In the event that the recipient received this report pursuant to a contract between the recipient and MLPF&S for the provision of research services for a separate fee, and in connection therewith MLPF&S may be deemed to be acting as an investment adviser, such status relates, if at all, solely to the person with whom MLPF&S has contracted directly and does not extend beyond the delivery of this report (unless otherwise agreed specifically in writing by MLPF&S). MLPF&S is and continues to act solely as a broker-dealer in connection with the execution of any transactions, including transactions in any securities mentioned in this report.

Copyright and General Information regarding Research Reports:

Materials prepared by BofA Merrill Lynch Global Research personnel are based on public information. Facts and views presented in this material have not been reviewed by, and may not reflect information known to, professionals in other business areas of BofA Merrill Lynch, including investment banking personnel. BofA Merrill Lynch has established information barriers between BofA Merrill Lynch Global Research and certain business groups. As a result, BofA Merrill Lynch does not disclose certain client relationships with, or compensation received from, such companies in research reports. To the extent this report discusses any legal proceeding or issues, it has not been prepared as nor is it intended to express any legal conclusion, opinion or advice. Investors should consult their own legal advisers as to issues of law relating to the subject matter of this report. BofA Merrill Lynch Global Research personnel's knowledge of legal proceedings in which any BofA Merrill Lynch entity and/or its directors, officers and employees may be plaintiffs, defendants, co-defendants or co-plaintiffs with or involving companies mentioned in this report is based on public information. Facts and views presented in this material that relate to any such proceedings have not been reviewed by, discussed with, and may not reflect information known to, professionals in other business areas of BofA Merrill Lynch in connection with the legal proceedings or matters relevant to such proceedings.

This report has been prepared independently of any issuer of securities mentioned herein and not in connection with any proposed offering of securities or as agent of any issuer of any securities. None of MLPF&S, any of its affiliates or their research analysts has any authority whatsoever to make any representation or warranty on behalf of the issuer(s). BofA Merrill Lynch Global Research policy prohibits research personnel from disclosing a recommendation, investment rating, or investment thesis for review by an issuer prior to the publication of a research report containing such rating, recommendation or investment thesis.

Any information relating to the tax status of financial instruments discussed herein is not intended to provide tax advice or to be used by anyone to provide tax advice. Investors are urged to seek tax advice based on their particular circumstances from an independent tax professional.

The information herein (other than disclosure information relating to BofA Merrill Lynch and its affiliates) was obtained from various sources and we do not guarantee its accuracy. This report may contain links to third-party websites. BofA Merrill Lynch is not responsible for the content of any third-party website or any linked content contained in a third-party website. Content contained on such third-party websites is not part of this report and is not incorporated by reference into this report. The inclusion of a link in this report does not imply any endorsement by or any affiliation with BofA Merrill Lynch. Access to any third-party website is at your own risk, and you should always review the terms and privacy policies at third-party websites before submitting any personal information to them. BofA Merrill Lynch is not responsible for such terms and privacy policies and expressly disclaims any liability for them.

Certain outstanding reports may contain discussions and/or investment opinions relating to securities, financial instruments and/or issuers that are no longer current. Always refer to the most recent research report relating to a company or issuer prior to making an investment decision.

In some cases, a company or issuer may be classified as Restricted or may be Under Review or Extended Review. In each case, investors should consider any investment opinion relating to such company or issuer (or its security and/or financial instruments) to be suspended or withdrawn and should not rely on the analyses and investment opinion(s) pertaining to such issuer (or its securities and/or financial instruments) nor should the analyses or opinion(s) be considered a solicitation of any kind. Sales persons and financial advisors affiliated with MLPF&S or any of its affiliates may not solicit purchases of securities or financial instruments that are Restricted or Under Review and may only solicit securities under Extended Review in accordance with firm policies.

Neither BofA Merrill Lynch nor any officer or employee of BofA Merrill Lynch accepts any liability whatsoever for any direct, indirect or consequential damages or losses arising from any use of this report or its contents.