TRADE SUSTAINABILITY IMPACT ASSESSMENT FOR THE NEGOTIATIONS OF A PARTNERSHIP AND COOPERATION AGREEMENT BETWEEN THE EU AND CHINA

Sectoral Study 1 of 5:

Machinery

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Contributions by:

Christoph Daniel Jia
Dr Long Guoqiang
Dr David Evans
Pierre Thieriot

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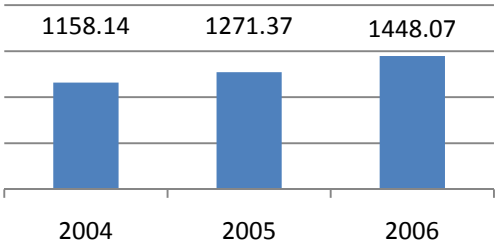
1. Background

The machinery sector is broad in definition, varying significantly between different studies by the United Nations, trade associations, scholars and governments. The machinery sector is generally part of the generic "Manufacturing" sector, and the definition used by the World Trade Organisation (WTO) includes power-generating machinery, specialised industrial machinery, metal working machinery, general industrial machinery and parts and electrical machinery. This will be the definition used in this report (see **Annex 1**).[1] The EU-China Trade Sustainability Impact Assessment's Global Analysis Report included a brief overview of all of the subsectors listed above, while this report will go into more detail and – following the WTO classification – remove the sub-categories "internal combustion piston engines, and parts thereof", "thermionic, cold cathode or photo-cathode valves and tubes" and "electrical equipment for internal combustion engines and vehicles, parts thereof".

1.1 Global Competitive Sector Context

Globally, the emergence of an industrial sector in developing countries and the drive for industrial modernisation has created strong demand for machinery. Emerging economies have been growing at a much faster pace than developed economies and the market they represent for machinery has been, and is likely to remain, a continued factor of growth for the global sector (see **Figure 1**). Machinery products have historically been produced in advanced economies because of the lack of mature customer industries in other parts of the world. However, recent trends show that several emerging economies are now producing machinery as well, first focusing on lower-end segments, particularly in the case of China.

Figure 1: World trade in machinery (US$ billion)



Source: WTO (2007)

Market access Obstacles: Tariffs and Non-Tariff Barriers

The machinery sector is fully subject to the rules set by the WTO, i.e. gradually lowering tariff and non-tariffs barriers. During the Doha Round, three "0/0 Agreements" have been reached in the machinery sector between selected WTO members, binding them to fully liberalise imports by the end of a transitional period.[2] Nonetheless, trade in the machinery sector is still constrained by significant trade barriers in developing economies. While developed countries have lower tariffs than in developing countries (between 2% and 3% for the European Community), in emerging economies with a growing machinery sector, high duties between 15% and 40% are maintained. Non-Tariff Barriers (NTBs) also represent a barrier to trade or investment when they discriminate foreign goods or investments, thus creating a

1 For the purposes of this study multiple definitions have been used in reference to the machinery sector, due to the availability of data. Regarding trade, the WTO definition referenced above and in **Annex I** has been utilised, using the SITC nomenclature for the 5 sub-sectors. Regarding production in Europe, the NACE nomenclature is utilised using Eurostat. Production in China, sourced from the China General Machinery Association database, the China National Bureau of Statistics, and the China Data Center, follows a different definition which has been elaborated where used in the text. In economic modelling the sector experts have made efforts to ensure consistency of data definitions by using disaggregated Chinese production data from the Yearly Industrial dataset of the China Data Centre. For more detail on data used please see **Section 4** of the Final Report.

2 DG Trade 2007.

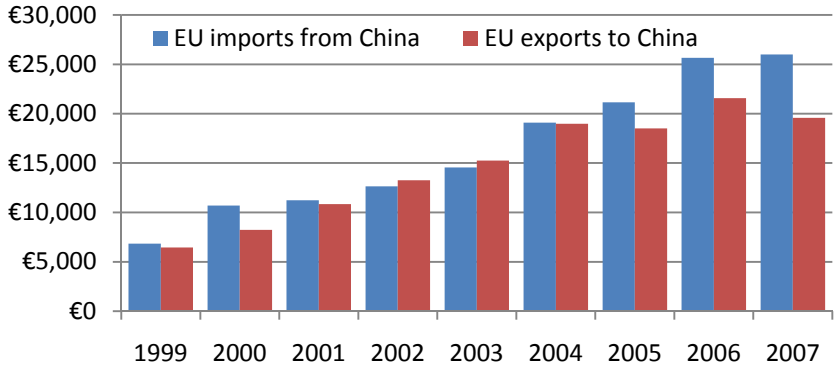
distortion between foreign actors and local ones who are artificially protected from competition. NTBs can consist of testing and certification, custom procedures, weak intellectual property protection and unfair government procurement procedures. Notably, not all Technical Barriers to Trade (TBTs) are considered illegitimate under the WTO framework, which permits barriers to exist when they are intended to protect health, consumer rights or the environment, as opposed to the strictly trade reducing objective of NTBs.

1.2 EU-China Specific Sector Context

Bilateral Trade: trends for the broad machinery sector

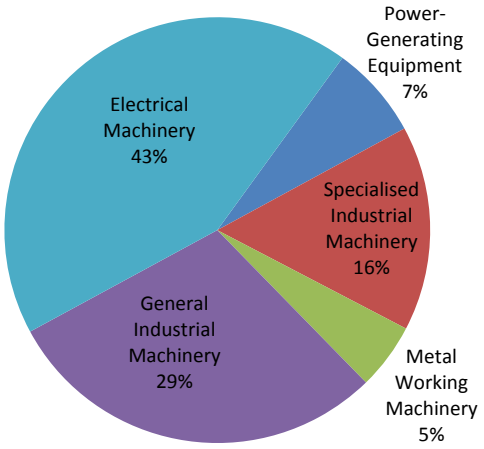
Machinery is a key sector for both the European Union and China, representing the largest trade goods sector, with bilateral flows valued at €45 bn in 2007. In 2007 China held a surplus of €6 bn, an ongoing reflection of a rapid increase in China's machinery trade surplus in recent years (see **Figure 3**). Until recently trade in this sector has been relatively balanced – in 2004, China's surplus was €109 mn. The China trade surplus has since grown to reach €4.1 bn in 2006.

Figure 3: EU27-China Bilateral Trade in Machinery 1999 – 2007 (millions)



Source: Eurostats

Figure 2: EU27-China total trade in machinery by sub-sector 2007



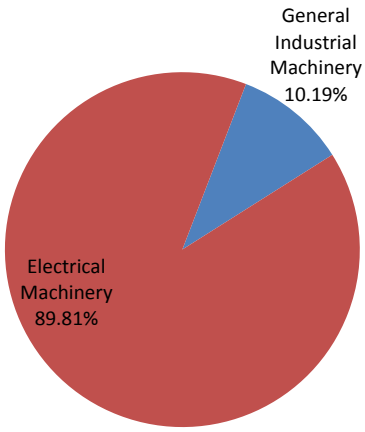
Source: Eurostats

The growing Chinese trade surplus is symptomatic of a flattening of the growth of machinery exported by the EU to China in the last few years. Several reasons explain this evolution: prior studies indicate that a number of obstacles exist to European machinery goods entering the Chinese market,[3] primarily Non-Tariff Barriers (NTBs) such as opaque legislation and complex regulations on trade and investment. Another reason is China's suspected currency undervaluation: between 2006 and 2007, the Euro has appreciated by over 10% against the Yuan (RMB), while the EU trade deficit with China more than tripled.[4] However, the machinery sector contributes only 3.8% to this deficit, in spite of being the largest source of bilateral trade (18.2% of €258 billion in 2006)[5]. Machinery in Europe has historically enjoyed a strong

3 Study on the Future Opportunities and Challenges of EU-China Trade and Investment Relations, Study 1: Machinery, Joachim Ihrcke and Krystina Becker, Droege & Comp. Singapore, 2006
4 Euro-Yuan exchange rates for 2006-2007 obtained from www.x-rates.com
5 DG Trade. EU-China Facts and Figures. 27 November2007. Available at: http://trade.ec.europa.eu/doclib/docs/2007/november/tradoc_136870.pdf

comparative advantage towards China, raising European concerns over recent developments.

Figure 4: EU27 Trade Deficit by Sub-Sector - 2007



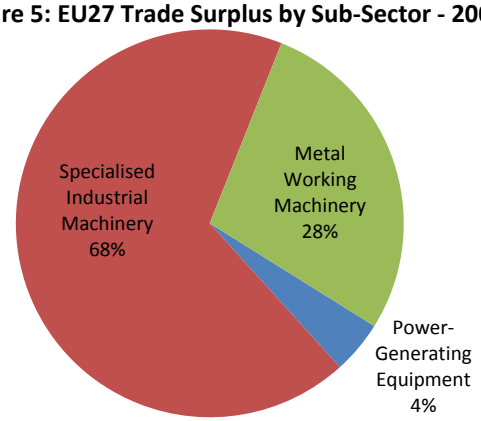
Source: Eurostats

A more detailed look at the EU-China trade for 2007 reveals that electrical and non-electrical machinery are dominant sectors (see **Figure 2**). Electrical machinery accounted for 43% of bilateral flows in 2007, valued at nearly €20 bn, of which Chinese exports accounted for €15 bn. Non-electrical machinery, inclusive of specialised industrial machinery with €7.1 bn (16% of total sector trade), general industrial machinery with €13.4 bn (29% of total sector trade) and metal working machinery with €2.3 bn (5% of total sector trade), accounted for €22.8 bn (40% of total sector trade). The last sub-sector, power-generating equipment, accounts for €3.2 bn, or 7% of total bilateral trade.

Bilateral trade: trade deficit and trade surplus by sub-sectors

European comparative strengths and weaknesses in trade are evident in the trade of machinery with China. The EU trade deficit in machinery is actually a consequence of a significant deficit in electrical machinery. As shown in **Figure 4**, electrical machinery is responsible for 90% of the deficit. It is even more striking when considered that exports of Chinese electrical machinery to the EU amounts to almost one third of the bilateral trade in machinery. Despite continuous growth in overall exports from EU to China in this sub-sector, the deficit has remained. China benefits from to low-cost, high-supply labour and government support for lower-value export products.[6] Within the general industrial machinery sub-sector, the EU has a deficit of €1.2 bn (€261 mn in 2006), despite growing exports, accounting for €6.6 in 2006 (+14% from 2005).

Figure 5: EU27 Trade Surplus by Sub-Sector - 2007



Source: Eurostats

This aggregated trade deficit in the machinery sector disguises important EU strengths. A favourable trade balance is held by the EU in the majority of sub-sectors, with a surplus of €5.3 billion (see **Figure 5**). Specialised industrial machinery is particularly strong, with a EU surplus of €3.6 billion (68% of the overall surplus), followed by metal working machinery with a surplus of €1.5 billion (28%). This reveals a sustained and solid European comparative advantage, particularly in machinery for which quality, service, innovation and energy efficiency are important factors. Similarly, in "Internal combustion engines, and parts thereof", the EU has a strong comparative advantage. The situation for power-generating equipment is ambiguous. Currently, trade flows are almost balanced: the EU enjoys in 2007 a minor trade surplus of €236 million (or 4% of overall surplus) in this sub-sector. Estimates show that the current deficit China maintains with the world (including the EU) is a downward trend and is expected to achieve a turn-around into a surplus.[7]

Market access Obstacles: Tariffs and Non-Tariff Barriers

Previous studies highlight that there are a number of restrictions to trade in place in China, despite the country's entry into the WTO in 2001[8] and some

6 These factors also exist in other sub-sectors of the machinery industry.
7 http://trade.ec.europa.eu/doclib/docs/2006/july/tradoc_129427.pdf
8 See for example: Study on the Future Opportunities and Challenges of EU-China Trade and Investment Relations, Study 1: Machinery, Joachim Ihrcke and Krystina Becker, Droege & Comp. Singapore, 2006

recorded progress since. Tariffs have been lowered to 8.5%[9] on average, but remain higher than those the EU applies, 3% on average.[10] Furthermore, China's average tariff disguises tariff peaks of 35% in some sub-sectors. A reduction in Chinese tariffs would alleviate the distortion that European companies face in competing with Chinese counterparts.

Non-Tariff barriers (NTBs) faced by European operators prior to 2001 still exist, restricting access to the Chinese market or imposing a discriminatory burden on business activities. Some obstacles relate to subsidies to domestic firms provided by national and local authorities; government procurement process; ownership restrictions (e.g. a ban on Wholly-Owned Foreign Enterprises (WOFE)); local content requirements; and standards and certification requirements. The significant differences in technical standards existing between the EU and China pose a crucial problem to European business, especially regarding industrial safety. Important adaptation costs resulting from safety requirements add to other costs, and uncertainty keeps companies from taking preventive measures to adapt their products to local standards.[11] The overall cost of NTBs for European companies in the non-electrical machinery sector alone is estimated to be approximately €7 billion per year in lost business opportunities.[12]

9 This figure is obtained by averaging imports tariffs of China, i.e. Most Favored Nation (MFN) applied tariffs (Source: WTO International Trade Statistics 2007): 8.3% for non-electrical machinery and 8.7% for electrical machinery. Note: these categories differ this sector study - see **Annex 1** on the WTO classification for its International trade Statistics.

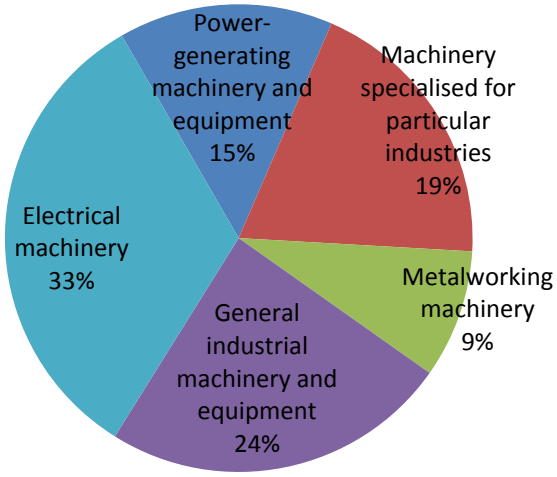
10 Source: European Commission

11 The 'incompatibility' of EU and Chinese legislation, scope and conformity assessment can leave European companies in a legal and regulatory haze.

12 Source: DS 2006-2010 study; quantitative analysis based on 2004 figures.

2. Baseline Scenario

Figure 6: Chinese Machinery Sector Output 2006



Source: China Yearly Industrial Data, China Data Centre

2.1 Economic Significance

Gross output of the machinery sector in China provides an overall sense of the sectors economic importance. In 2006 the sector is estimated to have accounted for over € 385 billion in output. Among this output, electrical and general industrial machinery contribut approximately one third and one quarter, respectively, while specialised machinery, power generating equipment, and metalworking machinery contribute smaller shares (see **Figure 6**).

2.1.1 Power-generating equipment

Machinery equipments are inputs into other industries' processes. In the case of the power-generating equipment, the main customer is the power industry,[13] which produces energy for the whole economy. Goods included in the power-generating equipment sub-sector include steam boilers, turbines, non-electrical engines and motors, and rotating electric plants.

The power industry holds a central position in China's development, providing power to fuel the booming economy. In the past decade, the demand for energy in China has soared faster than the power generating capacity. In 2006, total energy consumption grew faster than the power generated by 0.5%.[14] The power sector, with currently generates 2830 billion kW of energy (2006 figures), has been striving in recent years to raise its production capacity (622 mn kW in 2006) and improve its power grid system. In late 2004, the NDRC announced the construction of multiple large power plants with a targeted production capacity of 280 mn kW[15]. Prior to this announcement, a large number of small power-plants had been built to address energy shortages, a temporary solution due to their relative inefficiency. China has also been trying to develop a better connection between the regional power grids as well as a comprehensive power transportation system in order to bring more energy from the resource-rich provinces in the West to the power-thirsty provinces in the East.[16]

Efficiency remains a serious problem for the power industry and the whole economy in China. A certain number of factors hinder efficiency in the power industry, such as poor management, inefficient structures and imbalanced distribution.[17] This problem is worsened by the relative dominance of smaller, inefficient power plants, while the demand-side dynamic is worsened by inefficiency in consuming industries (3.5 times higher than the level in the USA and rising). With investment regulations implemented since 2004 Chinese authorities are cracking down on small, inefficient and/or unsafe power

13 The removal of the SITC category 713, "Internal combustion piston engines" resulted in making the power industry a customer of SITC category 71. "power-generating machinery and equipment".
14 USA Department of Commerce online, http://www.buyusa.gov/china/en/power.html
15 Study on the Future Opportunities and Challenges of EU-China Trade and Investment Relations, Study 1: Machinery, Joachim Ihrcke and Krystina Becker, 2006
16 NDRC, *China's Energy Conditions and Policies*, December 2007.
17 Ibid.

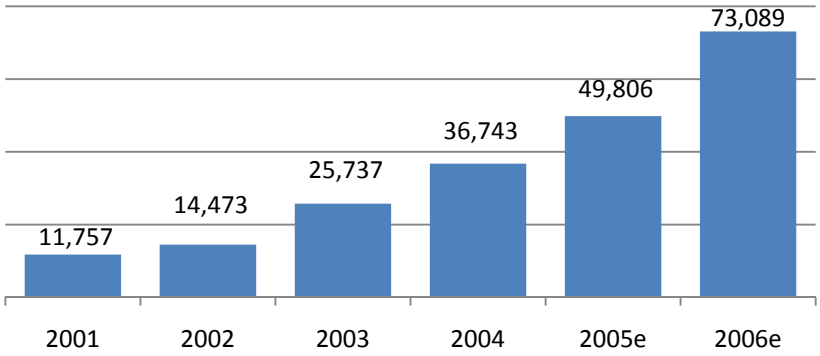
plants[18] and driving to limit over-investment in the sector.[19] Furthermore, a reform of the power industry in 2002 ended the state monopoly in the power industry: China's State Council dismantled the State Power Corporation (SPC) into 11 smaller companies. Other ongoing reforms aim at privatising a part of the state-assets included separating power generation and power supply networks, supporting competition and modernising pricing mechanisms. These reforms have progressed slowly and continue to face difficulties as acknowledged by the NDRC in 2007.[20]

These ongoing trends in the power industry, which is undertaking deep transformations and investing heavily to meet demand, are likely to impact the power-generating machinery sector. Indeed, the drive to raise power supply capacity is expected to have a direct effect on the domestic demand for power-generating equipment and represents new opportunities for the producers of such equipments, placing domestic companies, FIEs or foreign exporters in competition with each other to gain market share.

Situation in China

The importance of power-generating equipment in China is evident from its classification as an "encouraged industry" by the Ministry of Commerce (MOFCOM) in its 'Catalogue for the Guidance of Foreign Investment Industry'.[21] China's great need for energy has raised the attention of government officials and highlighted the need to support its development. The recent trend for the power-generating equipment sector in China is clearly upward, with strong and sustained growth (see **Figure 6**); however, several conflicting trends and different realities exist within the sector.

Figure 7: Sales of power-generating equipment in China[1](US$ million)



Source: China General Machinery Association database (2006)

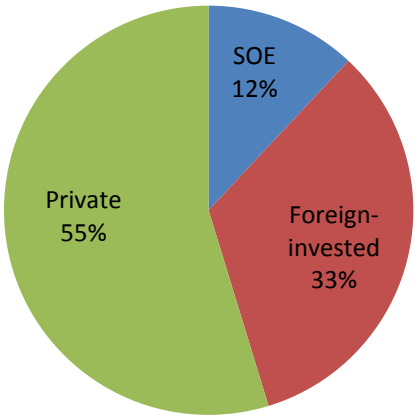
Under the pressure of soaring demand from the power industry, sales of power-generating equipment in China have experienced an impressive and uninterrupted upward trend in the recent period, to reachUS$73.1 bn in 2006.

18 A recent development is the revocation by the NDRC of the approval for 13 small coal-fired plants with a capacity of 2.44 GW, bringing the figure for 2007 to 365 plants (11 GW), from January to December. Source: Xinhua, 25 December 2007.
19 DG Trade, 2007.
20 NDRC, *China's Energy Conditions and Policies*, December 2007
21 www.zjgftz.gov.cn

Domestic consumption is slightly higher at US$73.3 bn, with China a net importer of power-generating equipment.[22]

It is important to go beyond the broad sales figures and to look at the share of sales per company type. In China, there are broadly three kinds of company, differentiated by their type of ownership: State-Owned Enterprises (SOEs),[23] private domestic companies and Foreign-Invested Enterprises (FIEs).[24] SOEs, who still accounted for one third of the sector in 2001 (both in terms of sales and number of enterprises), have seen their market share drastically reduced in four years (to 12% of total sales in 2006)[25] while ongoing restructuring in the sector resulted in a reduction of 30% in the number of state companies. This shift in the ownership structure has benefited private and foreign-invested enterprises, which accounted for 55% and 33% of total sales in 2006 respectively (see **Figure 7**), following double-digit growth over recent years. While all companies in the sector are large and medium-sized companies,[26] FIEs are significantly larger than other entities with an average industrial output ofUS$29.9 mn in 2006[27], versus US$19.3 mn and US$13 mn for SOE and private companies respectively.

Figure 8: Sales of power-generating equipment per company type 2006

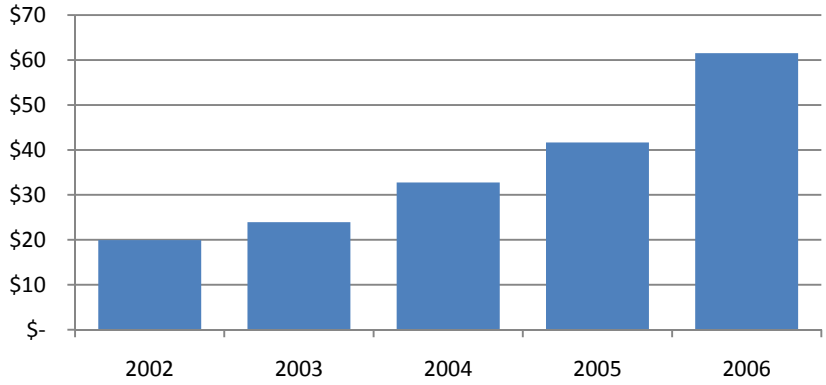


Source: China General Machinery Association database (2006)

The power-generating equipment industry experienced a strong growth in output productivity (33% year-on-year average between 2002 and 2006), mainly due to private and foreign-invested enterprises. SOEs still experience relative low levels of output productivity ($44,000 in 2006, i.e. 58% of FIEs' level and 72% of private companies), despite an increase in production and workforce reduction that helped to improve productivity (see **Figure 8**). Low productivity of SOEs can be linked to the rigidity of their employment structure, not allowing these companies to easily adjust their workforce to their commercial needs. The Chinese government strictly limits bankruptcy, closure or even downsizing of SOEs 'low performers', in an attempt to avoid social consequences that large scale lay-offs would have. One of the only options available is "early retirement", where the company keeps "retired" employees with a base salary, but without additional allowances.[28]

22 Sales in 2006 are estimated figures based on first quarter year-on-year growth rates.
23 The definition may vary depending on the classification. The definition used is: 100% state-owned companies, companies where state is the biggest shareholder and collective enterprises.
24 Wholly-Owned Foreign Enterprises (WOFE) – to use the Chinese terminology – are banned in China. Foreign entities have to form a partnership with a local enterprise to be allowed to operate in the country, which results in a large number of joint-ventures, or Foreign-Invested Enterprises. The reality behind these partnerships is very diverse, depending on the share of local capital; some FIEs have a very small part of their shares held by the Chinese partner, making them similar to WOFEs. Source: Study on the Future Opportunities and Challenges of EU-China Trade and Investment Relations, Study 1: Machinery, Joachim Ihrcke and Krystina Becker, Droege & Comp. Singapore, 2006
25 All figures are not inflation or currency adjusted. Exchange rate is fixed to 1 US$ = 8.28 RMB.
26 The average company producing power-generating equipment employs 269 persons, China General Machinery Association database.
27 All 2006 figures are estimates based on first quarter figures, China General Machinery Association database.
28 Study on the Future Opportunities and Challenges of EU-China Trade and Investment Relations, Study 1: Machinery, Joachim Ihrcke and Krystina Becker, Droege & Comp. Singapore, 2006

Figure 9: Output productivity of power-generating equipment in China (1,000)



1. output productivity: production output value per employee
2. output value 2006 estimate based on first quarter figures, employees as of March 2006

Source: China General Machinery Association database (2006)

Table 1 shows the economic performance of the power-generating industry on average and by type of ownership. The industry's profit margin (profit to sales ratio) experienced a steady growth, from 3.3% in 2002 to 5.9% in 2005, which is, however, relatively low. Indeed, a look at the percentage of loss-making companies reveals that in 2005 a quarter of them were not profitable, with FIEs not being an exception, 29% of them suffering losses. Surprisingly, SOE's profitability is higher than private or foreign-invested enterprises', which could be explained by the substantial state subsidies these companies – state-owned 'big players' in a 'pillar industry' – are likely to receive from central or local governments. [29] Returns on assets [30] data confirm that the apparent performance of SOEs is rather artificial: compared to private or foreign-invested enterprises, SOEs have a below average return on investment (5.5%), FIEs being the highest with a 9.4% ratio.

Table 1: Sector performance in China - Power-generating equipment

	2002	2003	2004	2005	2006
Profit margin (industry average)	3.3%	4.5%	5.5%	5.9%	5.5%
SOE	1.4%	1.8%	5.0%	7.0%	6.3%
Foreign-invested	5.7%	7.2%	6.7%	5.6%	4.5%
Private	3.4%	4.5%	5.0%	5.8%	5.9%
Return to assets (industry average)	2.2%	4.3%	6.0%	7.6%	10.5%
SOE	0.8%	1.3%	3.8%	5.5%	6.8%
Foreign-invested	5.4%	10.1%	10.8%	9.4%	11.5%
Private	2.1%	4.4%	5.4%	7.5%	11.5%

Source: China General Machinery Association database (2006)

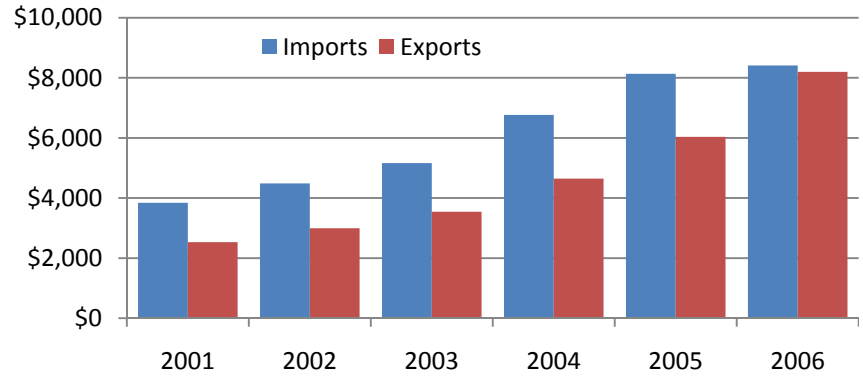
An analysis of trade performances in the sector completes the overview of China's power-generating equipment industry (see **Figure 9**). Until 2005 both exports and imports recorded solid growth rates (24% and 20% on average per year respectively), while China's trade deficit with the world was gradually narrowing. In 2006, imports stalled while exports kept soaring (+36%), resulting in a very small (US$213 mn) trade deficit for China. Over this period,

29 Ibid.

30 Assets include current assets, long-term investments, intangible assets, fixed assets, "amortised" assets (e.g. start-up fees)

only one sub-sector - "Rotating electric plants" - enjoyed a (sizeable) trade surplus, amounting to US$1.8 bn in 2006 and actually masking growing trade deficits in segments such as steam turbines, steam engines and motors. By analysing sub-categories, it is evident that China has growing needs for certain foreign goods, even in segments where its trade deficit turned into a surplus (steam boilers). For each sub-category of power-generating equipment, Chinese production does not totally satisfy the local market and, in parallel, China has turned toward third countries' with established performance and quality. This situation is likely to slow the evolution towards import substitution and the government's preference to see this strategic sector dominated by Chinese producers.

Figure 10: China's total imports and exports in power-generating equipment[1] (millions)

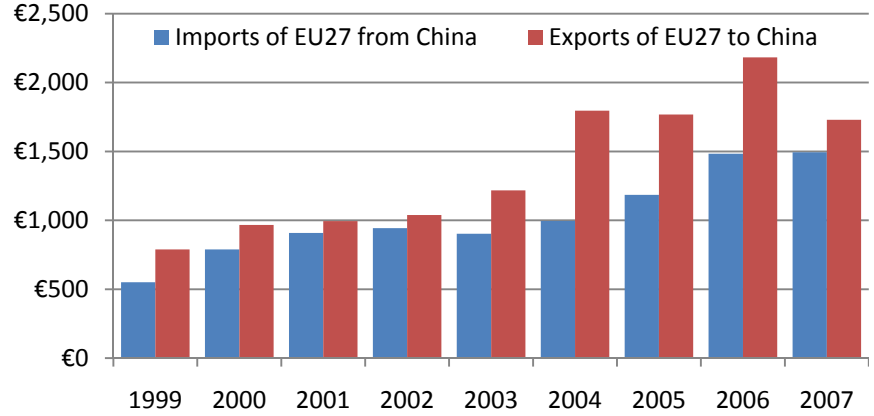


Source: UN Comtrade database (2007)

Bilateral trade flows of power-generation equipment and additional analysis per sub-category

While "power-generating equipment" is a minor sector in EU-China trade in machinery, ranking next to last before metal working machinery, the indirect role it plays in the functioning of the economy and society is of strategic importance.

Figure 11: EU27-China Trade in Power-Generating Equipment (millions)



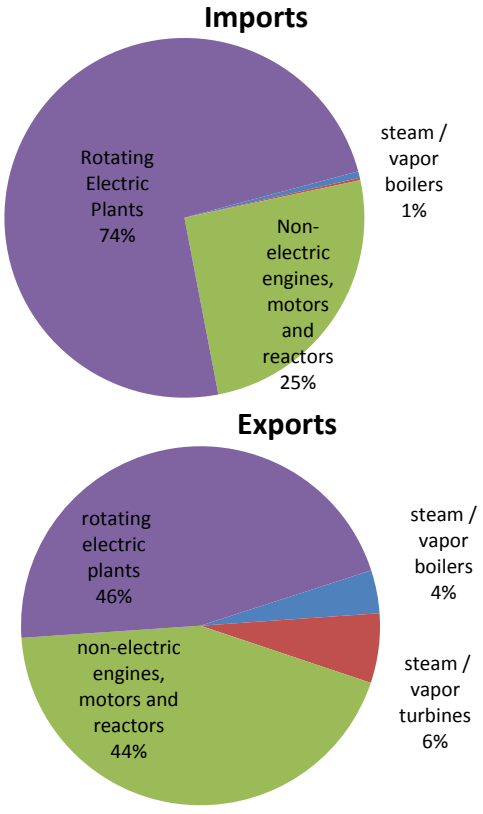
Source: Eurostats

The evolution of the bilateral trade relationship in the power-generating equipment sector (**Figure 10**) has been unexpected. The EU has always enjoyed a trade surplus, however, both the magnitude of the surplus and the growth rates of the trade flows vary significantly. While Chinese and EU's exports to each other grew in parallel until 2000, EU exports surged in 2004, stalled in 2005 before surging again in 2006, and falling abruptly in 2007, almost overtaken by Chinese exports that had been regularly increasing since 2004. This has resulted in a reduction of the trade surplus in favour of the EU to €236 mn in 2007, after a €801 mn peak in 2004.

The high volatility of these figures can be explained by the early development of the sector. China's power-generating equipment market has not yet matured, with ongoing growth and irregularity in its demand of local and foreign goods. The consumption of power-generating machinery in China has increased rapidly in recent years, met by local or by foreign producers. However, China is still unable to produce several kinds of power generating goods (particularly energy-efficient machinery). Recently, China has shown strengths in several areas, notably rotating electric plants (see **Figure 13**). Indeed, Chinese production in recent years has made important progress in goods where it historically has not enjoyed a comparative advantage.

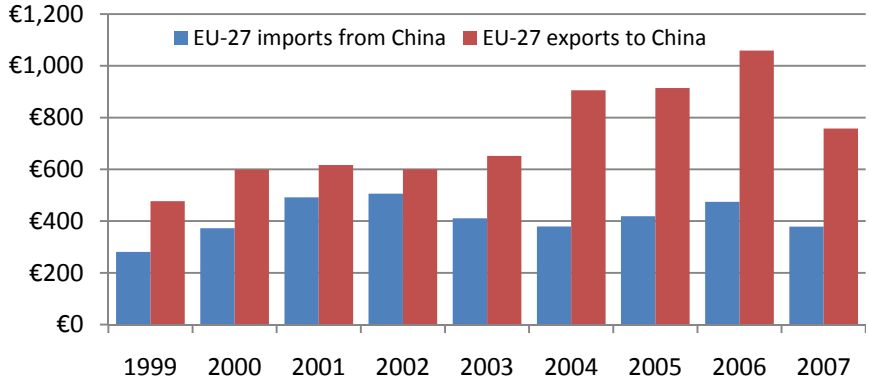
Figure 11 indicates the low significance of boilers and turbines in EU and China trade, with only 1% of EU imports (€11.2 mn) and 4% and 6% of its exports (or €67 and €108 mn), respectively. The greater trade significance lies in the non-electric motors and engines sub-sectors (**Figure 12** and **Figure 13**).

Figure 12: EU27-China Trade in Power-Generating Equipment by Sub-Sector - 2007



Source: Eurostats

Figure 13: EU27-China Trade in Non-electric motors and engines, reactors (millions)



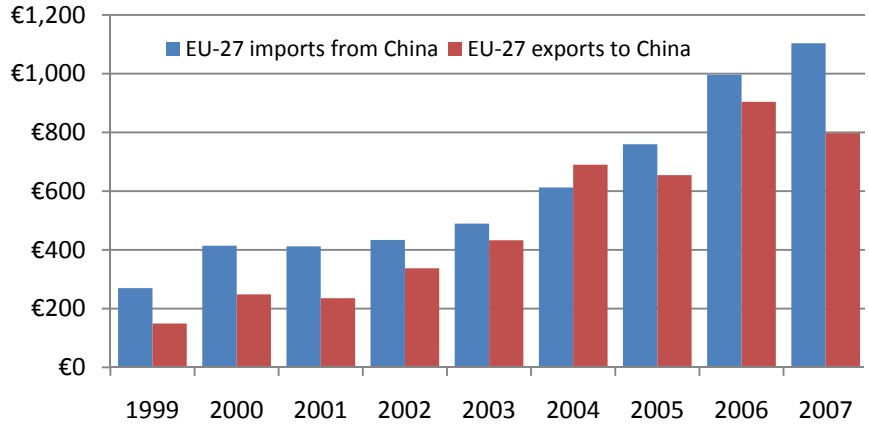
Source: Eurostats

For non-electric reactors, engines and motors the trend over the last decade follows the trend for the global power-generating equipment sector, only more marked: Chinese exports have been volatile and experienced difficulty penetrating the EU market, with exports in 2006 "only" 68% higher than in 1999, while EU exports to China increased by 122% between 1999 and 2006.

For rotating electric plants (58.9% of the bilateral trade in 2007), bilateral trade flows follow a strong upward trend: over the decade, bilateral trade has grown 4.5 times to reach €1.9 bn in 2007. With regards to the trade balance,

the EU has been lagging behind soaring Chinese exports, overtaking them only briefly in 2004. Still, the EU has gradually reduced its trade deficit, raising its bilateral export/import ratio to 91% in 2006 compared to 55% in 1999. Given the relatively small size of boilers and turbines in the EU-China bilateral trade in power-generating equipments, and the remaining competitive advantage of the EU in non-electric reactors, motors and engines, any turn-around of trade balance in favour of China is likely to be due to the evolution of the rotating electric plants segment.

Figure 14: EU27-China Trade in Rotating Electric Plants (millions)



Source: Eurostats

2.1.2 Non-Electrical Machinery

The non-electrical machinery sector is a catch-all sector which includes machinery that cannot be included in the power-generating equipment or electrical machinery sub-sectors. “Mechanical engineering” is another widely used term for this sector.[31] Mechanical engineering is a highly diversified industry, ranging from machinery used by special industries like textile or agriculture to machine-tools working metal and appliances like pumps, transmission shafts or others.

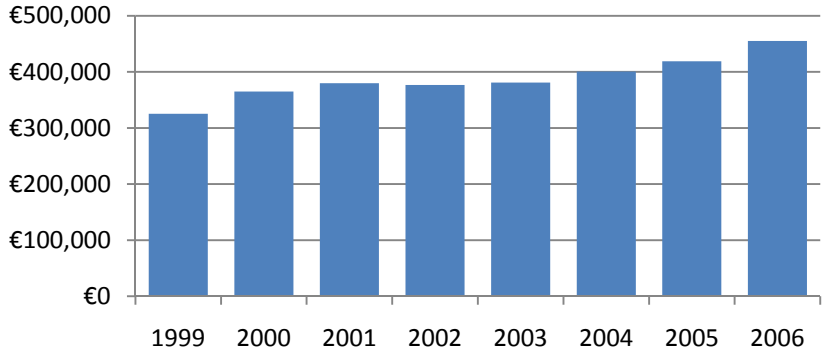
Today’s mechanical engineering sector has been described as a multi-technology industry, involving not only machines but also electronics, software and services into complex production and processing systems. [32] This knowledge-intensive, high value-added sector is an “enabling industry” that provides other sectors with production means and technologies. Mechanical engineering is critical to the supply and value chain of other industries, driving innovation and productivity for industries such as food production, textiles, furniture, automotive, shipbuilding, materials handling, agriculture, construction, electronics, aerospace and defence. It also provides services related to its products such as improvement of existing processes. The industry participates moreover indirectly to the economy as a customer of the primary and - increasingly - service sectors.

31 Notably by the EC’s DG Enterprise and Industry.
32 “EnginEurope”, For a thriving European Mechanical Engineering industry in the 21st century; Report and recommendations of the “EnginEurope” High-Level Discussion Group; European Communities, 2007.

Situation in Europe

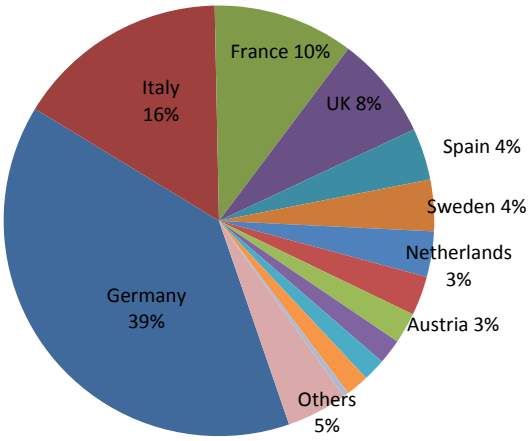
With some 24,000 companies, mechanical engineering is one of the largest sectors in Europe, accounting for 8% of the total manufacturing output with sales totalling €459 bn in 2006 (up by 8.6 % from 2005 and expected to grow by 4.5% in 2007) (see **Figure 15**). 63% of the production is sold within the EU and the remaining share (37% or €169.4 bn) is exported to third countries. Mechanical engineering provides the highest value added through exports of all economic sectors in Europe, and has a trade surplus of €102.5 bn for the EU-27 in 2006.

Figure 16: EU27 Output in Mechanical Engineering[1]



Source: DG Industry and Enterprise 2007.
Note: the output is for EU25 until 2001 and for EU27 since 2002

Figure 15: EU27 Mechanical Engineering Output by Member State - 2006



Source: DG Enterprise and Industry 2007

All main producing countries belong to the old EU15 (see **Figure 14**). Among new member states, two countries have an engineering output (electrical and non-electrical machinery) above €10 bn, Poland and Czech Republic, the latter specialised in heavy machinery. Romania is a more modest producer, with €1.8 bn, due to heavy machinery inherited prior to market reforms.

Output productivity and profit to sales ratios hold high levels in Europe: €176,501 per employee and 0.34 respectively on average in 2006, compared to US$43,000 per employee (2006 estimates) and 0.06 (2005 value) in China.[33]

33 Source: China General Machinery Association database

Table 2: Mechanical Engineering Sector Performance by Member State - 2006

Rank	Country	OUTPUT PRODUCTIVITY	ADDED VALUE/OUTPUT	OUTPUT (in € Mn)	SHARE IN EU27 OUTPUT
1	The Netherlands	230,662	0.313	15,685	3.4%
2	Finland	226,745	0.292	10,657	2.3%
3	Sweden	224,962	0.334	17,772	3.9%
4	Italy	208,625	0.284	73,436	16.0%
5	Austria	205,439	0.364	13,559	3.0%
6	Germany	205,183	0.351	179,125	39.1%
7	France	204,882	0.303	48,557	10.6%
8	UK	171,760	0.382	35,726	7.8%
9	Denmark	165,212	0.391	8,591	1.9%
10	Spain	151,525	0.354	17,880	3.9%
11	Czech Rep.	61,876	0.303	7,982	1.7%
12	Poland	53,027	0.395	7,742	1.7%
13	Romania	18,894	0.279	1,776	0.4%
	China	34,372	0.05[1]	184.12	

Source: DG Enterprise and Industry 2007; China General Machinery Association database (2006)

Table 2 differentiates three groups of producers. 'Small' producers such as the Netherlands, Finland, Sweden and Austria perform well, along with 'big players' such as Italy, Germany and France. Other large producers such as the United Kingdom and Spain, along with Denmark, also perform well, even if their output productivity is below average. The last group of countries, relatively "low performers", is composed of former state-planned economies: Czech Republic, Poland and Romania, the latter having a very low level of output productivity (€18,894 per employee). **These countries' mechanical engineering sector is the most 'vulnerable' within the EU because they are more exposed to competition with third countries such as China.** Recent history explains this phenomenon: the political reform in Eastern Europe required an industrial restructuring[34] that was only partially followed by labour force adjustments. However, production and output productivity have had an upward trend in recent years, a sign that these industries are gaining competitiveness. From a global perspective, the mechanical engineering sector is not hampered by the low performance of these producers: altogether, their output only accounts for 3.8% of the EU27's total, while the "high performers" output accounts for 78.4% of the total. Surprisingly, the profit to sale ratio is high for all the main producers, meaning that they all enjoy considerable production depth.

The mechanical engineering industry requires a high level of innovation; an area in which EU industry is particularly strong, resulting in a competitive advantage in customised machinery and niche markets. Productivity and high value added constitutes a protection against the risk of "commoditisation".[35] Despite high labour costs, high regulatory requirements and threats from increasing global competition, European operators have been able to invest in R&D, enabling them to face the challenge of declining products' life cycles and maintain its position as world leader in many areas. Another advantage lies in

34 "Introduction to the Mechanical and Electrical Engineering Sectors of new EU Member States", Institute for Economic Research at the University of Munich, November 2005.

35 "EnginEurope", For a thriving European Mechanical Engineering industry in the 21st century; Report and recommendations of the "EnginEurope" High-Level Discussion Group; European Communities, 2007.

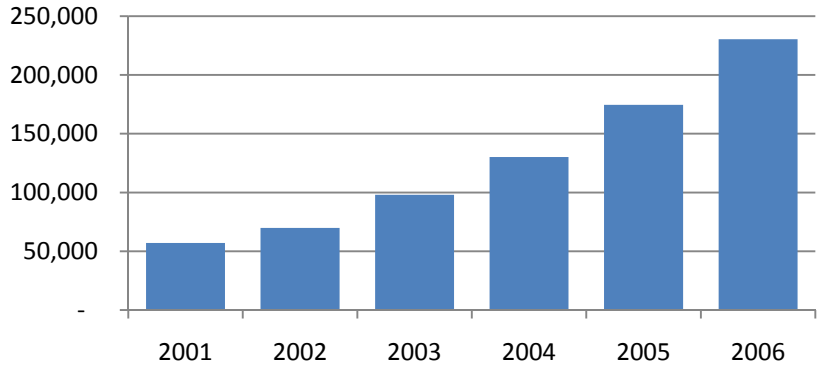
the ownership structure of the companies: in Europe, most of the non-electrical machinery industry is composed of SMEs, with more than 20 persons and often family-owned. The leaders of these small entities – which are also global companies – are competent in evaluating the international market and simultaneously maintaining quality social employee relations.

EU non-electrical machinery also faces serious challenges that will need to be addressed rapidly: competition worldwide is intensifying; producing countries in the developing world are modernising their industry and expanding beyond their local markets; and customers are ever more demanding of service quality and environmental sustainability, making innovation more crucial than ever. The EU also has additional burdens: a comparative disadvantage in manufacturing costs, low labour mobility and discriminatory treatment in external markets.

Situation in China

Sales of non-electrical machinery have increased 4 fold from 2001 to 2006, or a 32% per year surge on average (see **Figure 17**). As a result, the domestic market purchased US$245.5 bn of non-electrical machinery in 2006 - net imports included.

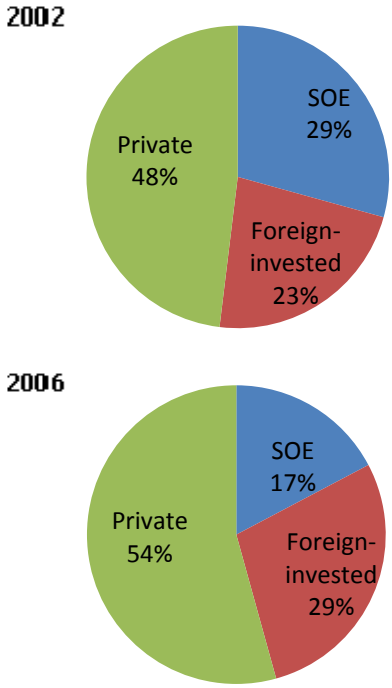
Figure 18: Sales of non-electrical machinery in China (US$ million)



Source: China General Machinery Association database (2006)

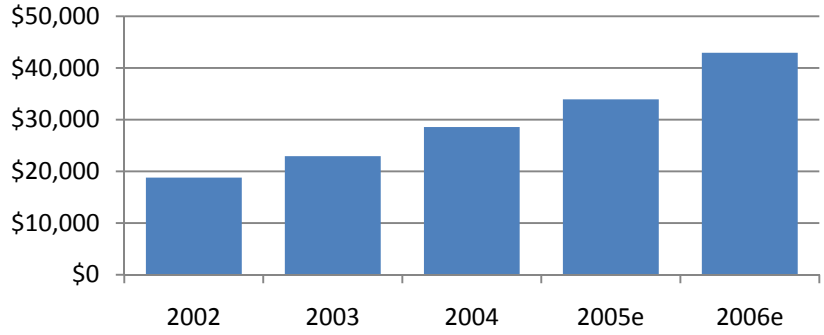
Unlike power-generating equipment, companies operating in the non-electrical machinery sector in China are relatively 'small', both in term of workforce and sales, in particular private domestic enterprises (US$4.9 mn sales and 155 employees on average in 2005). **Figure 16** highlights the share of sales attributable to the different entity forms. Similar to the power-generating sector, the non-electrical sector undertook an important restructuring of its SOEs, with a similar impact on its market share (down from one third of the business in 2002 to 11% of the total number of enterprises and a market share of 17% in 2006), benefiting private and foreign-invested enterprises (6% market share increase for each).

Figure 17: Sales of non-electrical machinery per company type, 2002 and 2006



Source: China General Machinery Association database (2006)

Figure 19: Output productivity in the non-electrical machinery industry in China



Source: China General Machinery Association database (2006)

In recent years the non-electrical machinery sector has enjoyed growth in output productivity (23% per year on average); although this has been lower than the power-generation equipment sector (see **Figure 18**). Again, workers in foreign-invested enterprises proved to be the most productive, with an output per employee of US$49,000 in 2005, far above private domestic companies and SOEs (with US$33,000 and US$25,000 respectively). **Table 3** confirms this trend and shows that higher levels of output productivity match higher profitability: in 2005,[36] FIEs recorded a profit margin of 8%, slightly downward, while private companies' ratios remained stable at 5.3%. With a profit margin of 3%, SOEs lag despite progress over recent years (up from 1.4% in 2002). However, almost a third of the FIEs were loss making in 2006 (30%), for an industry's average of 23%. In regards to returns on assets (ROI), FIEs again rank first with an average return of 8% for every dollar used. Private companies show a performance similar to the industry's average, while SOEs' ROI is very low at 2% and barely increasing over the years.

Table 3: Sector Performance in China – Non-electrical Machinery

	2002	2003	2004	2005	2006
Profit margin (industry average)	4.9%	5.2%	5.3%	5.6%	5.5%
SOE	1.4%	1.2%	2.2%	3.0%	3.0%
Foreign-invested	8.9%	9.1%	8.2%	7.9%	7.6%
Private	5.1%	5.4%	5.3%	5.3%	5.3%
Return to assets (industry average)	3.3%	4.1%	4.9%	5.7%	7.2%
SOE	0.7%	0.7%	1.4%	2.1%	3.1%
Foreign-invested	7.0%	8.5%	8.2%	8.3%	10.1%
Private	4.3%	5.2%	5.7%	6.1%	7.3%

Source: China General Machinery Association database (2006)

These figures also include state subsidies in the companies' accounting, which is realised before the calculation of the above ratios. If direct and indirect subsidies from the government were removed, it is likely that the share of loss-making SOEs would be higher than the current figure of 37%, implying that a potentially large majority of SOEs operating in the non-electrical machinery sector are not economically viable. This context informs the protection of this sector from foreign competition, as it accounted for

36 2006 data are estimated based on first-quarter statistics only.

US$278 bn in 2006[37] and employs 5.3 million persons (including 1.1 million in SOEs alone).

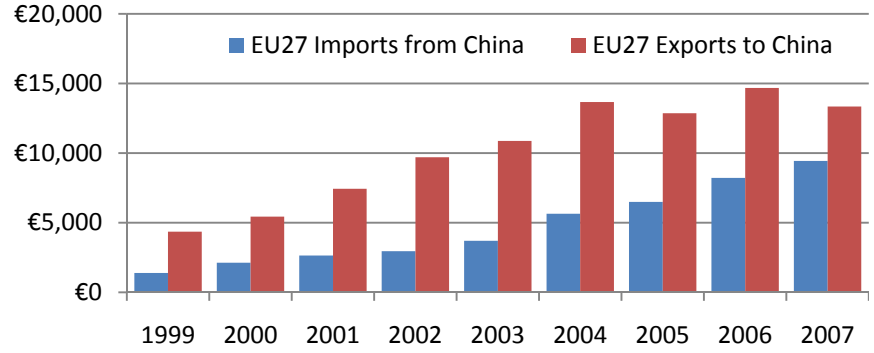
Figure 20: China's total imports and exports of non-electrical machinery (US$ millions)

Source: UN Comtrade (2007)

Between 2001 and 2006, the trade deficit in non-electrical machinery has narrowed, both in absolute and relative terms, but the benefit of this evolution is entirely attributable to the last three years (see **Figure 19**). Until 2003/04, Chinese imports of non-electrical machinery were increasing considerably faster than its exports (+17.4% per year on average versus +12.5%), resulting in a two fold increase of the trade deficit in absolute value. After 2004, imports stalled while exports surged at a significantly higher rate of 21% per year on average. As a result, Chinese imports of non-electrical machinery from the rest of the world were only 30% higher than its exports in 2006, compared to 150% in 2001. China remains dependent on imports of certain goods, including "general machinery" where its trade deficit turned into a surplus in 2005. However, unlike the power-generating equipment sector, this situation cannot be generalised to all sub-sectors: after 2004, China's imports of "specialised machinery" started to decrease despite growing domestic consumption.

Bilateral Trade Flows

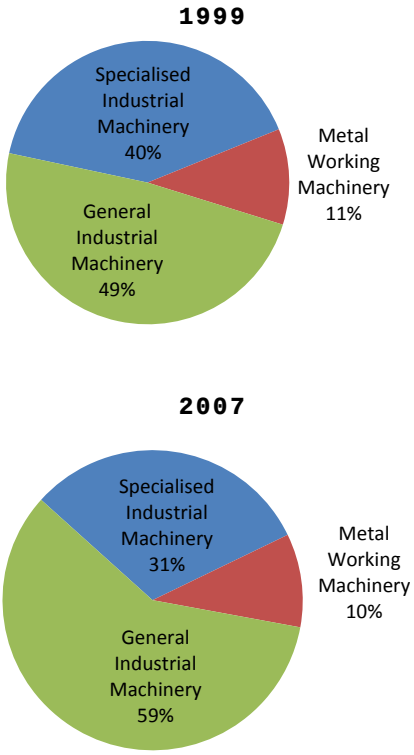
Figure 21: EU27-China Trade in Non-Electrical Machinery (millions)



Source: Eurostats

37 total domestic sales (China General Machinery Association database 2006) plus exports (UN Comtrade 2007) in 2006.

Figure 22: EU27-China Total Trade in Non-Electrical Machinery by Sub-Sector

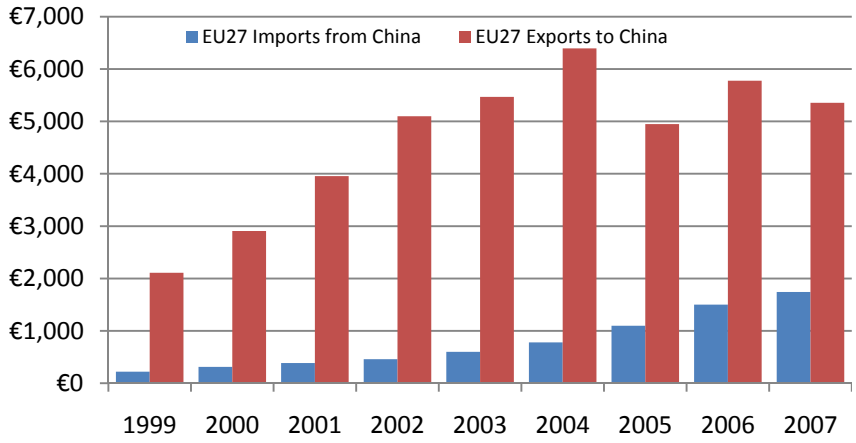


Source: Eurostats

The non-electrical machinery sector accounted for one half of the bilateral trade in machinery between EU and China in 2007, amounting to €22.8 bn, with an average growth rate of 19.5% over the last decade (see **Figure 21**). While EU exports stalled in 2004, the rise of imports from China continued, increasing by €1 bn per year to reach €9.4 bn in 2007, up from only €1.4 bn in 1999. This resulted in a narrowing of the trade surplus, not immediately visible looking at the absolute values, since both flows experience a strong upward trend over the period. In 1999, the export/import ratio was 3.1 and decreased to 1.4 in 2007.

As the non-electrical machinery covers a very large and diverse range of machinery products, it is important to break down the data and analyse the trends in the three areas that compose the sector (see **Figure 22**). A comparative outlook for years 1999 and 2007 shows that metal working machinery remained stable at 10% of the total trade, while the share of general industrial machinery progressed at the expense of specialised industrial machinery (from 49% to 59% of the total trade). This development can be attributed to the weak growth of Chinese exports of specialised industrial machinery to the EU (growth of €1.5 bn between 1999 and 2007) (see **Figure 23**).

Figure 23: EU27-China Trade in Specialised Industrial Machinery (millions)



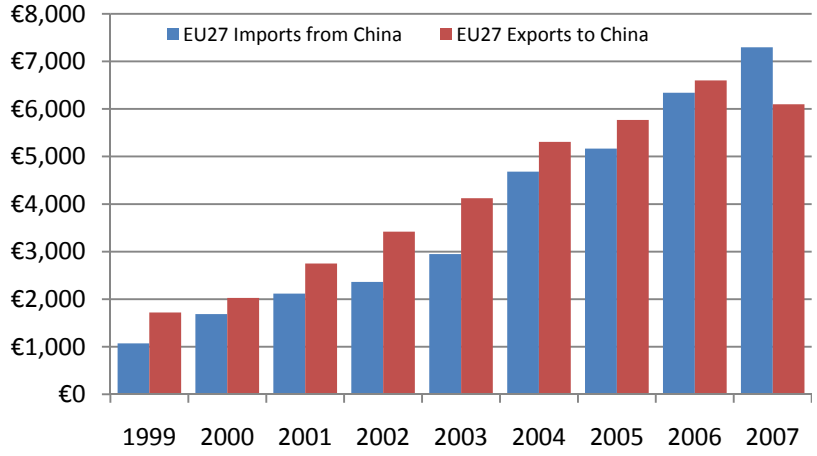
Source: Eurostats

A historical perspective highlights the similarity of specialised industrial machinery and metal working machinery sub-sectors: after strong growth between 1999 and 2004, the progress of EU exports to China stalled, while Chinese imports followed a slight growth until 2003/04 and a significant acceleration afterwards (see **Figure 23**). In both sectors, however, EU exports remain much higher than its imports. EU exports of specialised machinery grew at steady rates until 2004 to reach €6.4 bn (€2 bn for metal working machinery), before slowing down to €5.3 bn in 2007 (€1.9 bn for metal working machinery). Chinese exports, only accounting for €600 mn in 2003 (€149 mn for metal working machinery), surged to €1.7 bn four years later (€381 mn for metal working machinery).

Figure 24: EU27-China Trade in Metal Working Machinery (millions)

Source: Eurostats

Figure 25: EU27-China Trade in General Industrial Machinery (millions)



Source: Eurostats

Concerning general industrial machinery, in the last eight years EU exports to China have multiplied by 3.5 and Chinese exports to the EU by almost seven (see **Figure 24**). Until 2006 the EU enjoyed trade surplus in general industrial machinery, but in 2007 incurred a €1.2 billion trade deficit. This reveals a growing comparative advantage of China in this segment. The most probable explanation is Chinese producers increasingly turning towards emerging foreign markets in this sector.[38]

2.1.3 Electrical machinery

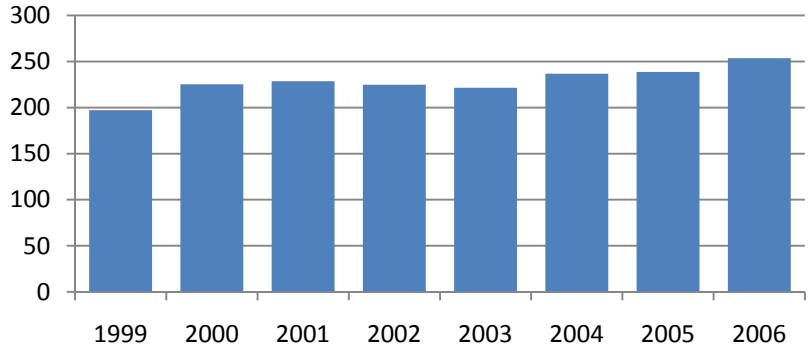
The list of goods included in the electrical machinery sector refers to electric power machinery; electric circuits apparatus; insulated conductors and equipment; electrodiagnostic and radiological apparatus; household equipment and small electrical machinery (like batteries, lamps, tools, etc).[39]

38 Study on the Future Opportunities and Challenges of EU-China Trade and Investment Relations, Study 1: Machinery, 2006
39 Other than rotating electric plants

Unlike the first two sub-sectors of machinery – power-generating equipment and non-electrical machinery – the electrical machinery sector comprises equipment for professional and also consumer products. Some sub-sectors are also 'dual-use', i.e. they supply demand from both consumers and professionals. The main difference between the two categories is their markets, which have radically different characteristics – notably regarding competition. The degree of technology of electrical machinery products is not as high as for the other machinery sub-sectors analysed. Increasingly, more countries have the technological knowledge to produce electrical machinery products and a certain number of emerging economies are growing into 'big players' in this segment of machinery, the best example being China, with 19.8% of the global trade in 2005 (up from 8.4% in 1999).[40]

Situation in Europe

Figure 26: EU27 Output in Electrical Machinery (billions)



Source: DG Enterprise and Industry 2007

The electrical machinery industry, with some 11,315 companies, has a share in the total manufacturing output of approximately 4%, and sales amounting to €251 bn in 2006 (up by 7% from 2005)[41] (see **Figure 25**). 75% of production is sold within the EU (40% in national markets) and the remaining share (25%, or €63.3 bn) is exported to third countries. With imports accounting for €54.5 bn, the EU27 electrical machinery sector enjoyed a trade surplus of €8.8 bn in 2006. Prices have slightly increased (+1.7% per annum for the sectoral index, below inflation), but with a 5% hike in 2006, may be a sign of overheating.[42] The main producing countries, classified by their share of European output, are: Germany (34%), Italy (14%), France (12%), Spain (8%) and the United Kingdom (7.5%). Electrical machinery is also an important sector in the Netherlands[43] and Sweden, and a promising one in Central and Eastern European countries such as Czech Republic, Hungary (growing faster than the EU average), Slovak Republic (contributing to strong growth in the workforce).[44] New EU members, Romania and Bulgaria, have historically a sizeable electric machinery industry sector, which does not appear in the EU27 figures (they represent 0.7% and 0.3% of the EU27 total output 2006

40 Figure calculates the ratio of imports and exports of China from and to the world economy (Source: UN Comtrade) to a proxy of the global trade, i.e. world total of exports (Source: UNCTAD).
41 Source: www.bara.org.uk/EAMA/press%20info%20economic%20outlook%20-%20spring%202007.doc
42 "EU Engineering Competitive Update", DG Enterprise and Industry, June 2007.
43 Xinhua, 17 December 2004
44 Vienna Institute for Economic Studies, March 2007.

respectively).[45] After being effected by significant economic restructuring in the 1990s the sector is becoming competitive again and is gradually recovering its production capacity.

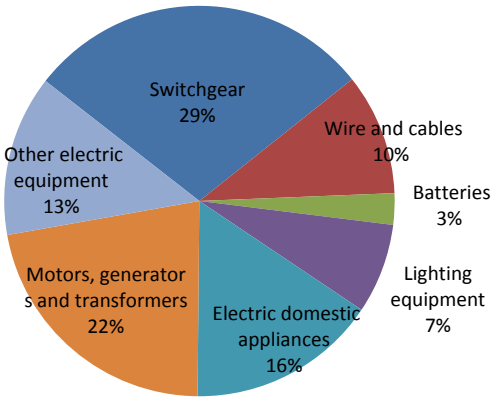
Output productivity and profit to sales ratios stand at fairly high levels in 2006: €152,000 per employee and 0.31 respectively, while in China these indicators amount to US$43,953 per employee and 0.05 respectively.[46] **Table 4** breaks down the sector's output productivity by main producing country and compares it to the country's profit to sales ratio and output in order to evaluate the sensitivity of the electrical machinery industry for the different countries and the EU27 as a whole.

Table 4: Electrical Machinery Performance by Member State – 2006

Rank	Country	Output productivity (€)	Profit to sales ratio	Output (in € Mn)	Share in EU27 output
1	Italy	196,556	0.26	35,380	14.0%
2	Germany	190,316	0.33	84,881	33.5%
3	Spain	184,579	0.29	19,750	7.8%
4	France	171,765	0.30	29,200	11.5%
5	Sweden	153,947	0.33	5,850	2.3%
6	UK	148,438	0.37	19,000	7.5%
7	Hungary	92,143	0.35	6,450	2.5%
8	Poland	71,504	0.28	8,080	3.2%
9	Czech Rep.	50,320	0.28	6,290	2.5%
10	Slovakia	45,000	0.22	2,115	0.8%
11	Romania	29,412	0.24	2,000	0.8%
	China	35,134	0.05	5,727	

Source: DG Enterprise and Industry 2007; China Statistical Yearbook (2006)
Note: data for China is for 2005

Figure 27: EU27 Electrical machinery output per sub-sector 2006



Source: EU Engineering Competitive Update, DG Enterprise and Industry, June 2007

Table 4 also reveals three distinct groups of producers. Unlike "non-electrical machinery", 'small' producers do not have high output productivity, with the exception of Sweden. "Low performers" are all producers coming from former state-planned economies: Hungary, Poland, Czech Republic, Slovakia and Romania, the latter having – again – a very low level of output productivity (€29,412 per employee). Unlike other countries, the electrical machinery sector accounts for the largest share of their production in machinery (between 44% and 70%, versus 24 and 52%), exposing them more to international competition than other EU producers, even if their electrical machinery industry is supported by FDI from EU15 and other overseas countries.[47] From a global perspective, the output of 'low performers' accounts for a sizeable 9.8% of the EU27's total output, raising concerns of localised risks. Their profit to sales ratio is slightly lower than other producers' (0.27 versus 0.31), but still considerably higher than that of emerging

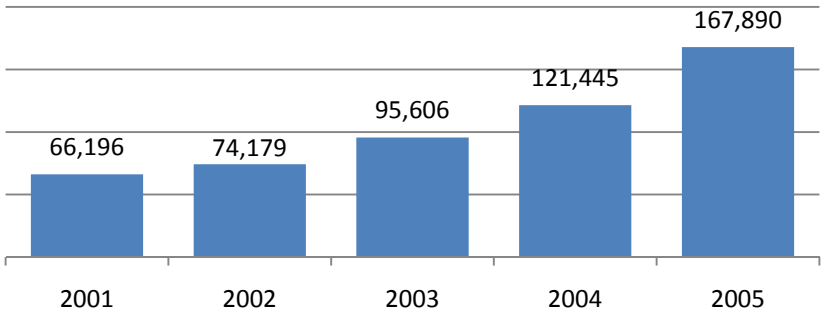
45 Within the EU Engineering Competitive Update (DG Enterprise and Industry, June 2007) the machinery sector definition differs slightly from the one used in this analysis. While that study included vehicle motors (SITC 7783) and excluded medical devices (SITC 774), this study excludes vehicle motors, groups other motors (i.e. generators) into Power Generating Equipment, and does include medical devices.
46 Source: China Statistical Yearbook (2005).
47 Source: DG Enterprise and Industry. In DG Enterprise and Industry classification (using NACE), the two sub sectors of mechanical engineering and electrical machinery cover the three SITC sub-sectors with power-generating equipment being split between mechanical engineering and electrical machinery.

players'.[48] **Figure 26** illustrates the share of electrical machinery per sub-sector in the EU in 2006 (Romania and Bulgaria included).

Situation in China

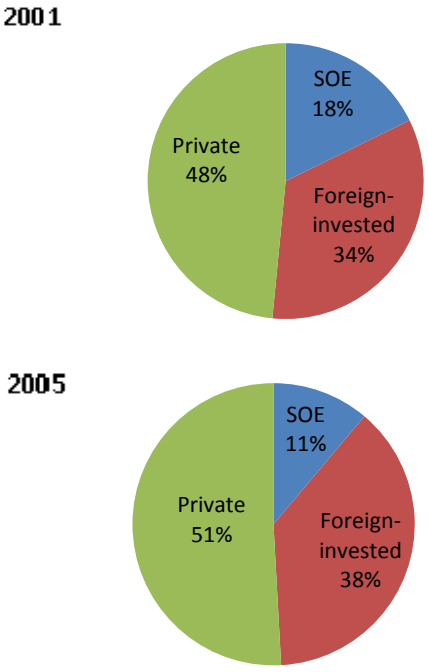
Sales of non-electrical machinery have increased 2.5 times from 2001 to 2005, or 26% per year on average (see **Figure 27**). The domestic market purchased US$148.7 bn of electrical machinery in 2005 – with net exports deducted.

Figure 28: Output of electrical machinery in China 2001 - 2005 (US$ million)



Source: China Statistical Yearbook (2002 – 2006)

Figure 29: Sales of electrical machinery in China by company ownership



Source: China Statistical Yearbook (2002 and 2006)

Companies operating in the electrical machinery sector are not as large as the power-generating equipment sector, but they are relatively large compared to the average companies manufacturing non-electrical machinery, both in terms of workforce and sales (US$10.9 mn sales and 245 employees on average in 2005). **Figure 28** reveals the share of sales attributable to each entity form.[49] The impact of SOEs restructuring does not appear to be as strong in the electrical machinery sector compared to the other machinery sectors during the period covered. This is most likely due to the comparatively earlier restructuring of SOEs manufacturing electrical machinery. Indeed, the share of SOEs in the market of electrical machinery was relatively low in 2001 (18%). The bulk of SOEs market share reduction occurred during the 1990s. The market share further shrunk in recent years (down to 11%), benefitting of foreign-invested enterprises who increased their market share by 4 percentage points.

Unlike other machinery sectors, overall average output productivity in the electrical machinery industry has stagnated in recent years, despite a slight increase in 2005 to US$43,000 per worker. The domestic private sector recorded the highest output productivity ($96,136 per worker), far above average, while SOEs and FIEs lag far behind, the latter – quite surprisingly – ranking last with an output productivity of US$40,039.

48 Apart from the United Kingdom, all the main European producers experienced a growth in their mechanical engineering output over recent years, including "low performers". For the period covered (1999 onwards), the recovery of former state-planned countries' industries, like Romania, was already underway.
49 The data for the share of private companies has been obtained with the following formula:
PPS = PT – (PSOE + PFIE)
where P – Production, PS – Private Sector, SOE – State Owned Enterprise, FIE – Foreign Owned Enterprise

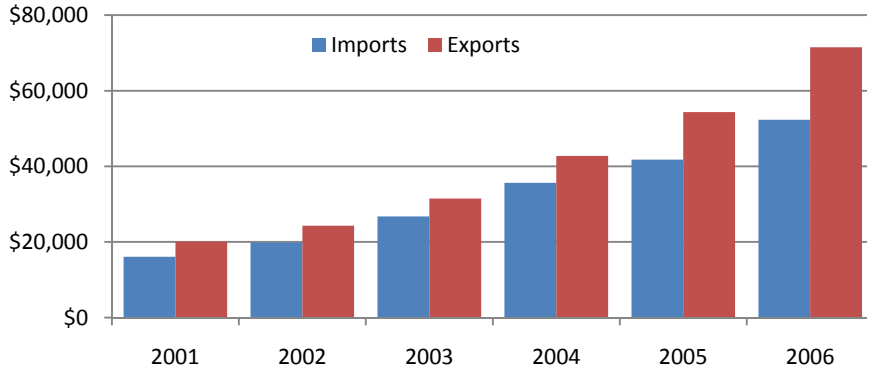
Table 5: Sector Performance in China – Electrical Machinery

	2001	2002	2003	2004	2005
Profits to sales ratio	4.6%	n.a.	n.a.	4.8%	4.8%
SOE	2.3%	1.7%	1.6%	4.0%	4.8%
Foreign-invested	6.1%	6.1%	6.2%	5.3%	5.0%
Private	4.4%	n.a.	n.a.	4.7%	4.6%
Return on Assets (Profits/Assets)	4.08%	n.a.	n.a.	5.51%	5.79%
SOE	1.11%	0.86%	0.81%	2.43%	3.64%
Foreign-invested	5.99%	6.39%	7.04%	6.88%	6.66%
Private	5.20%	n.a.	n.a.	5.94%	5.94%

Source: China Statistical Yearbook (2002 - 2006)

Table 5 contradicts these findings by revealing that foreign-invested businesses enjoy the highest profitability: despite a downward trend, FIEs recorded in 2005 a profit margin of 5%, while private companies' ratio remained stable at 4.6%.[50] SOEs, with weak profit margins in the early 2000s, are catching up with their competitors and outperformed domestic private companies in 2005. However, more than a third of the FIEs are loss-making in 2006 (30%), for an industry average of 17%. FIEs comprised 24% of loss-making companies. Concerning returns on assets (ROI), FIEs, again, rank first with an average return of 6.6%. Private companies show a performance similar to the industry's average, while SOEs ROI is rather low, even if considerably higher than previous years.

Figure 30: China's imports and exports in electrical machinery (millions)



Source: UN Comtrade database (2007)

Electrical machinery is the only machinery sub-sector where China enjoys an overall trade surplus (US$19 bn in 2006) (see **Figure 29**). Both imports and exports recorded a strong and steady growth over recent years, respectively +27% and +29% per year on average, figures that are consistent with domestic production's growth rate. Until 2003, imports grew faster than exports, yielding to an increase of imports in domestic consumption (29% in 2003). This trend has more recently reversed and the share of imports in domestic consumption decreased slightly in 2005 (to 27%). However, the continued growth of imports after 2003 (24% per year on average) renders it difficult to conclude on the existence of an import substitution trend, with imports, exports and domestic production recording very similar growth rates.

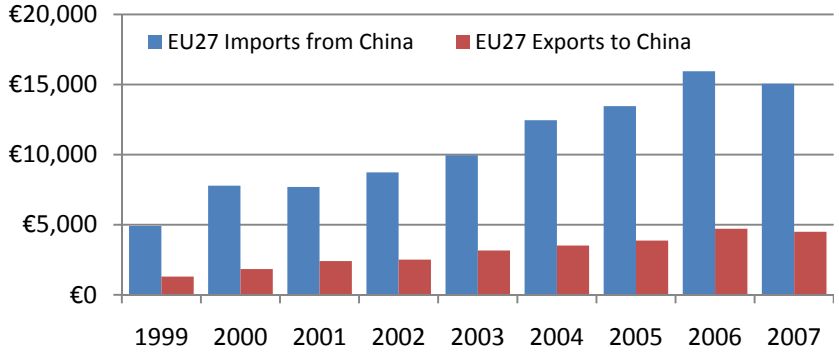
An analysis per sub-sector shows that China is running up a trade deficit in two sub-categories of electrical machinery: "electrical apparatus for electrical circuits" (SITC 772) and "Electro diagnostic apparatus" (SITC 774). Despite export growth, China's increasing need of foreign goods has widened its trade

50 2006 data is estimated based on first-quarter statistics and are therefore to be handled with caution.

deficit in absolute value in these sub-sectors, even if there is a trend towards stabilisation. If its exports keep growing at the same pace, however, China could become a net exporter of these goods in the near future. Among other sub-sectors, household appliances lead Chinese exports, accounting for 21% of exports of electrical machinery and 80% of the trade surplus in 2005. In all categories, however, imports keep growing, demonstrating that there is no sector where China does not need more foreign equipment. The opportunity for foreign producers is to specialise to increase their competitiveness in these sub-segments.

Bilateral trade flows

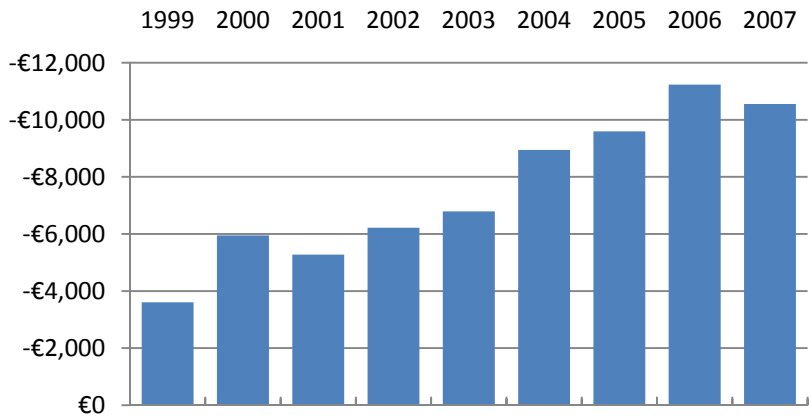
Figure 31: EU27-China Trade in Electrical Machinery (millions)



Source: Eurostats

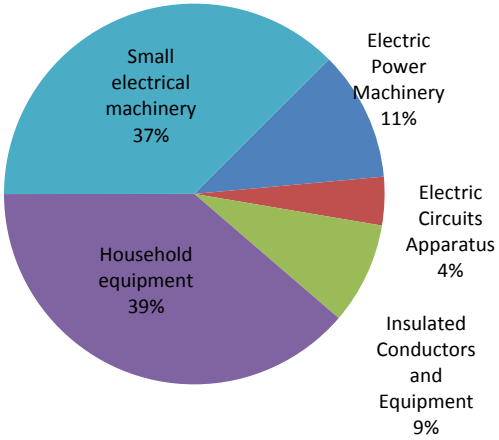
In total, the electrical machinery sector accounted for 43% of the bilateral trade in machinery between the EU and China with €19.5 bn in 2007, up from €6.2 bn in 1999 (see **Figure 30**). It is the most important share in the machinery sector. The trade balance is strongly in favour of China, with a trade surplus of €10.5 bn in 2007, after a peak of €11.2 bn the year before. The trade balance is also stable, with the EU's imports-to-exports ratio remaining at around 3.5 over the years. This should not mask, however, the sustained growth of EU exports to China in all categories of electrical machinery over the recent years. **Figure 32** shows the evolution of the EU electrical machinery trade deficit with China: since 1999, it has almost tripled, growing at an average rate of 18.6% per annum.

Figure 32: EU27 electrical machinery trade deficit with China (millions)



Source: Eurostats

Figure 33: EU27 Electrical Machinery Trade Deficit to China by Sub-Sector - 2007



Source: Eurostats

Figure 33 shows the structure of the EU trade deficit. In six categories, the EU only enjoys a (modest) surplus in one, 'Electro diagnostic and Radiological Apparatus' (SITC 774). The sectors in deficit are, in order of scale, household equipment (SITC 775), accounting for 39 % of the total deficit with €4.2 bn in 2007; small electrical machinery (SITC 778) with €4 bn (or 37 % of total deficit); electric power machinery (SITC 771) with €1.2 bn (or 11% of total deficit); insulated conductors and equipment (SITC 773) with €935 mn (or 9% of total deficit) and electric circuits and apparatus (SITC 772) with €444 mn (or 4% of total deficit). From a historical perspective, EU trade deficit in all categories points towards permanence, with the exports to imports ratio varying only slightly, as the evolution of imports, exports and trade balance in each category is similar to the global evolution of the electrical machinery sector.

The 'Electrodiagnostic and Radiological Apparatus' sector comprises equipment used by medical and veterinary sciences, like electrocardiographs, X-ray devices, radiography and radiotherapy devices. The characteristics of such devices, high-technology and importance in the treatment of human health issues, can provide an explanation of the dominance of Europe in this sector. However, this dominance may not last: while EU exports were more than seven times higher than imports in 1999, this ratio fell gradually to 2.7 in 2007 (see **Figure 34**). The small size of this category in the trade of electrical machinery (in terms of economic size) – 3% of the bilateral trade - limits the impact of such a scenario.

Figure 34: EU27-China Trade in Electrodiagnostic and Radiological Apparatus (millions)

Source: Eurostats

2.2 Social Significance

Various economic sectors have different interactions with the environment and society as a whole. With regards to social interactions and impacts, this study will focus on employment and existing workforce trends in the EU and China, as well as their sensitivity and resilience to change. While it is important to analyse the primary 'social significance of the industry (i.e. employment), this analysis also addresses other areas such as labour standards, issues related to gender, and overall social cohesion.

2.2.1 Employment

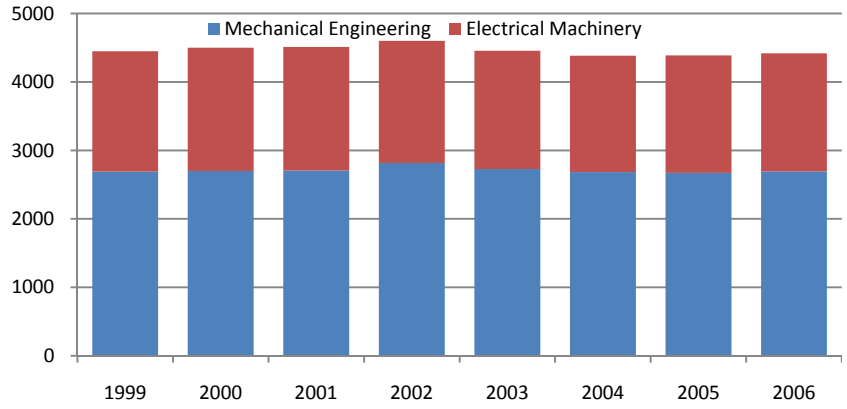
Changes in quality, cost, availability and adaptability of the labour force will determine the output and value-added, i.e. the creation of wealth. Beyond this, the workforce is also characterised by its social significance. Workforce, or "factor labour", or "human capital", represents citizens who hold an occupation in order to support themselves and their family. The state of the workforce is therefore closely correlated with the level of living standards and relates to issues such as poverty, public health and education.

Jobs in the machinery industry are generally more concentrated in specific geographic areas rather than dispersed over the entire territory as in service sectors. Infrastructure, transportation routes, access to markets and local institutional frameworks determine the location of industrial facilities and are the main factors explaining the concentration of industrial output. This concentration often results in the industry being a major employer in the specific regions where it is located, with other local employers often depending directly on this activity (subcontractors for the machinery industry's inputs, various small and medium-sized businesses for the employees' consumption). Significant changes in the machinery industry's activity can have important positive or negative social impacts.

Social Situation in Europe

Figure 34 highlights the upward and downward trends in machinery sector employment in the EU, with overall sector employment peaking in 2002. However, due to a lack of data for new member states before 2002, the figures visible before 2005 have limited accuracy and may under report historical employment. When considering the size of employment in the non-electrical sector in Romania and Bulgaria between 2002 and 2006, it is plausible that the global trend has actually been downward until 2004/2005 (a 4.7% decline during this period using pre-2002 Romania and Bulgaria estimates), only interrupted in 2006 by a marginal increase (+0.6%) of the workforce corresponding with a surge of 30,000 workers, 70% of them in the mechanical engineering sector.

Figure 35: EU27 Machinery Sector Workforce (x 1,000 persons)



Source: DG Enterprise and Industry, 2007

Note: Until 2001 the figure for the mechanical engineering workforce does not include Romania and Bulgaria

Employment trends within the last decade contrast with the economic performances in the machinery sector; while employment has declined there has been vigorous growth in output (and exports for mechanical engineering) as well as advances in productivity and profitability. Increasing competition has placed pressure on European manufacturers to remain competitive by modernising production processes and reducing manufacturing costs. An improvement in productivity helps maintain or grow markets. Reducing labour costs, particularly in electrical machinery, explains the reduction in the workforce while output continued to grow. While this development may be viewed positively as a sign of quality management and innovation, the social impacts are nonetheless painful for the newly unemployed of a declining workforce.

There is a popular belief in Europe that job losses in the manufacturing sector are mainly due to relocalisation by companies pursuing reduction in manufacturing costs by off-shoring to emerging economies where wages are lower. [51] European workers' have had to accept wage moderation to avoid job losses. It is true that the manufacturing sector represents a majority of the jobs off-shored (51.5% of the total for the period 2003 – 2006)and it is also true that the share of machinery in jobs relocated is higher than its share in total employment (15.5% of the total job relocated, for 2.25% of the total workforce). [52] However, relocalisation is responsible for a minor portion of the reduction in the sector in the EU (2% for electrical machinery and 0.3% for "machinery and equipment") and when it occurs, it is largely from the EU15 towards the new Member States rather than towards other regions such as Asia. [53] When broken down by sub-sector, it is apparent that electrical machinery is hit more seriously than the other machinery sub-sector, accounting for 11.4% of the total jobs off-shored with a share in the total

51 See Hamilton, Daniel S., ed. *Globalization and Europe: Prospering in the New Whirled Order* (Washington, D.C.: Center for Transatlantic Relations, 2008), p. 122 for more detailed definitions.

52 European Restructuring Monitor.

53 Ibid - the study defines EU "as Belgium, Denmark, Germany, Ireland, Spain, France, Italy, the Netherlands, Austria, Portugal, Finland, Sweden and UK, where cases of delocalisation have been concentrated".

workforce of less than 1%.[54] Again, the new facility destinations are mainly located in the new Member States rather than in Asia (the notable exception of Finland, and to a lesser extent Italy and France, who predominantly relocated to Asia). The positive impacts from this relocalisation of machinery production facilities should also be noted, such as export growth, a reduction in inflation, relative consumer income growth, competitiveness and productivity gains, and higher returns on capital.[55]

Table 6: EU27 Machinery Sector Employment by Member State

Rank	Country	Mechanical Engineering	Electrical Machinery	TOTAL	Share
1	Germany	873,000	446,000	1,319,000	29.9%
2	Italy	352,000	180,000	532,000	12%
3	France	237,000	170,000	407,000	9.2%
4	UK	208,000	128,000	336,000	7.6%
5	Poland	146,000	113,000	259,000	5.9%
6	Czech Rep.	129,000	125,000	254,000	5.7%
7	Spain	118,000	107,000	225,000	5.1%
8	Romania	94,000	68,000	162,000	3.7%
9	Sweden	79,000	38,000	117,000	2.6%
10	Hungary	44,000	70,000	114,000	2.6%
11	Austria	66,000	30,000	96,000	2.2%
12	Holland	68,000	19,000	87,000	2%
13	Slovak Rep.	38,000	47,000	85,000	1.9%
14	Denmark	52,000	23,000	75,000	1.7%
15	Finland	47,000	20,000	67,000	1.5%
	Others	142,000	141,000	283,000	6.4%
	TOTAL EU27	2,693,000	1,725,000	4,418,000	100%

Source: DG Enterprise and Industry, 2007

The sector's impact on individual member states ranks differently compared to the classification by "size of output", which reveals gaps in productivity but also the social significance of the machinery sector for each country (see **Table 6**). The biggest producers - Germany, Italy, France and United Kingdom – have the biggest workforce, which is understandable given their major share in both sectors of the EU machinery output. Sweden and Spain are emerging big players as well, with a strong economic growth that may lead to larger 'social significance' in the future. For 'low performers', 'social significance' corresponds to a 'social exposure', i.e. the vulnerability of these countries' employment to international competition. Romania, Poland and the Czech Republic are indeed the most 'sensitive' regions within the EU27, with a large workforce and output productivity at low levels (particularly in Romania). While Hungary and Slovakia have a significantly smaller workforce, they are specialised in electrical machinery, a field where emerging producers are becoming increasingly competitive. Despite its larger workforce, Hungary may be in a better position than its northern neighbour due to relatively strong output productivity of €45,000 (versus €30,000 in Slovakia).

54 Ibid - the study defines two machinery sectors: "Machinery + equipment" and "Electrical machinery".
55 Ibid

Table 7: Machinery Sector Employment Trends by Member State 1999 – 2006

Country	Workforce 2006	1999 - 2006 Variation	Growth Path
Slovak rep.	47	+62%	↗ ↗
Czech Rep.	254	+22%	↗ ↗
Hungary	70	+12.9%	↗ ↘
Austria	66	+8.2%	↗ ↔
Spain	225	+7.6%	↗ ↔ ↔
Sweden	117	+5.4%	↗ ↘ ↗
Italy	532	-1.2%	↗ ↘
Finland	47	-2.4%	↗ ↘
Germany	1319	-3.7%	↗ ↘ ↗
France	407	-4.5%	↗ ↘
Holland	68	-6.6%	↗ ↘
Romania	162	-9%	↘ ↗ ↘
Denmark	52	-11.2%	↔ ↘
Poland	259	-16.5%	↘ ↘ ↗
UK	336	-25.0%	↘ ↘

Legend:
The arrows describe the 'growth path' of the workforce for each country over the period 1999 to 2006, reflecting growing, declining, or stable employment figures. For example, workforce in Spain followed an upward trend and then remained stable.

Source: DG Enterprise and Industry, 2007

Key: red: countries specialised in electrical machinery; green: countries specialised in mechanical engineering; orange: countries with a large output in both sectors.

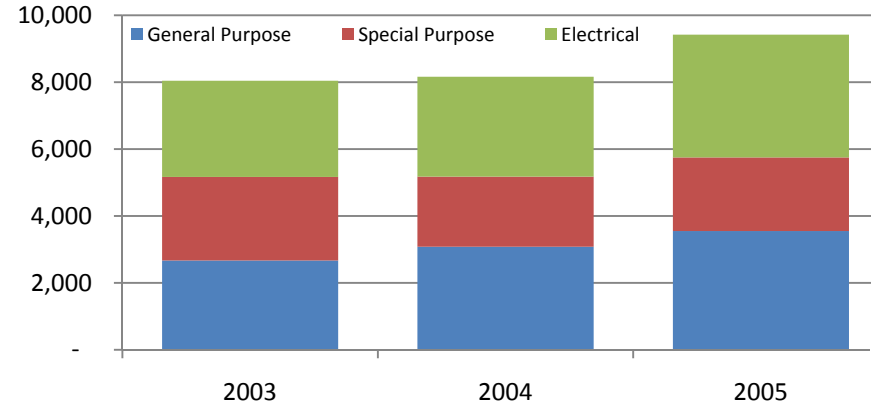
An analysis of the historical trends in the machinery workforce further highlights the 'social significance' of the machinery sector in Europe, where major producers are downsizing their workforce (see **Table 7**). [56] In the case of the United Kingdom, the only country whose output has decreased during the period, an uninterrupted fall of 25% has been experienced between 1999 and 2006. France is suffering significantly more than Germany and Italy, with a loss of 4.5% to 407,000 persons employed in 2006, while Spain is the most successful 'big' producer in terms of employment, gaining 16,000 workers in seven years (despite a slight loss in the electrical machinery sector). Meanwhile, the 'low performers' have had differing experiences over the past decade. While all these countries increased their output in both sectors over the last decade, this growth has been much stronger in the Czech Republic, Slovakia and Hungary and has been accompanied by an expansion of the workforce (with a peak growth rate of 62% for Slovakia). On the contrary, Romania and Poland continued losing workers (-9 and -16.5% respectively between 1999 and 2006). In addition to output growth trends, FDI is viewed as a significant determinant of employment growth, as Western European producers have invested in manufacturing facilities in select Central and Eastern European countries (especially Czech Republic and Slovakia), taking over old facilities and expanding production capacity.[57] Poland, which enjoyed strong FDI in both sub-sectors and declining employment, is a notable exception to this explanation.[58]

56 For the countries specialised in one sector, the data does not cover the other sector.
57 Introduction to the Mechanical and Electrical Engineering Sectors of new EU Member States, Institute for Economic Research at the University of Munich, November 2005
58 Ibid.

Another element to be taken into account is the skill level of those employed in the machinery industry. In both the mechanical engineering and electrical machinery sectors, labour costs in Europe are high and represent a competitive disadvantage of European industry in the international arena.[59] Skilled workers, however, remain competitive relative to their counterparts in emerging economies and employment will therefore be better protected against reductions in business activity. This is exemplified in the mechanical engineering sector, where Europe continues to produce high-tech goods, but much less in electrical machinery, a sector that in general requires relatively less highly qualified workers.

Social Situation in China

Figure 36: Machinery Sector Workforce[1] in China 2003 – 2005 (x 1,000 persons)



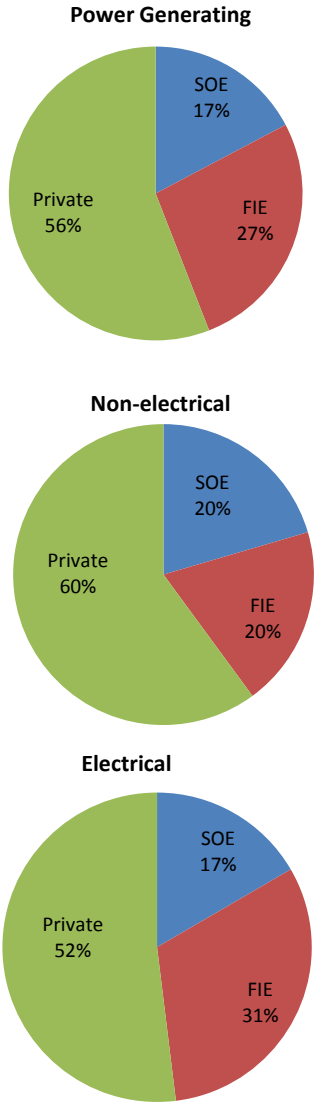
Source: China Statistical Yearbook (2004 to 2006)

After slight growth in 2004 (+1.5%), mainly due to a 17% cut in specialised machinery employment, sector employment in China increased significantly in 2005 (+15% overall) to reach 9.4 million persons (see **Figure 35**).[60] During the period for which data is available both the "general machinery" and "electrical machinery" workforce enjoyed an enviable annual average growth of 15%. While the specialised machinery workforce declined in 2004, its situation reversed in 2005 with 4.8% growth. It is expected that the workforce in specialised machinery will continue to grow, supported by favourable economic indicators (growing production and exports, decreasing imports).

Sizable labour productivity gains have been achieved at a rate exceeding overall employment growth (compared to a workforce decline in Europe), highlighting the economic gains of the sector. However, a main factor behind this performance – the availability of low-cost labour – may lose significance in the near future. Recent trends point towards acute labour shortages in the manufacturing sector in Guangdong province, where a large number of workers have not returned after 2008 New Year holidays due to growing discontent with low wages and poor working conditions.[61] In response factories have raised wages and improved working conditions in order to secure a stable employment base. In 2006 wage growth in Guangdong was as

59 In 2006, 22% and 24% in terms of production or 71% and 72% in terms of value-added for electrical machinery and mechanical engineering respectively (Source: DG Enterprise and Industry for the EU25; figures for Romania and Bulgaria are similar).
60 We assume here that SITC 72 "Specialised machinery" matches China Statistical Yearbook category "Special purpose machinery".
61 Between 11% (Guangdong Labour Ministry) and 30% (other estimates). Source: China Briefing, 17 March 2008.

Figure 37: China Machinery Employment by Subsector and Ownership - 2006



Source: China General Machinery Association Database

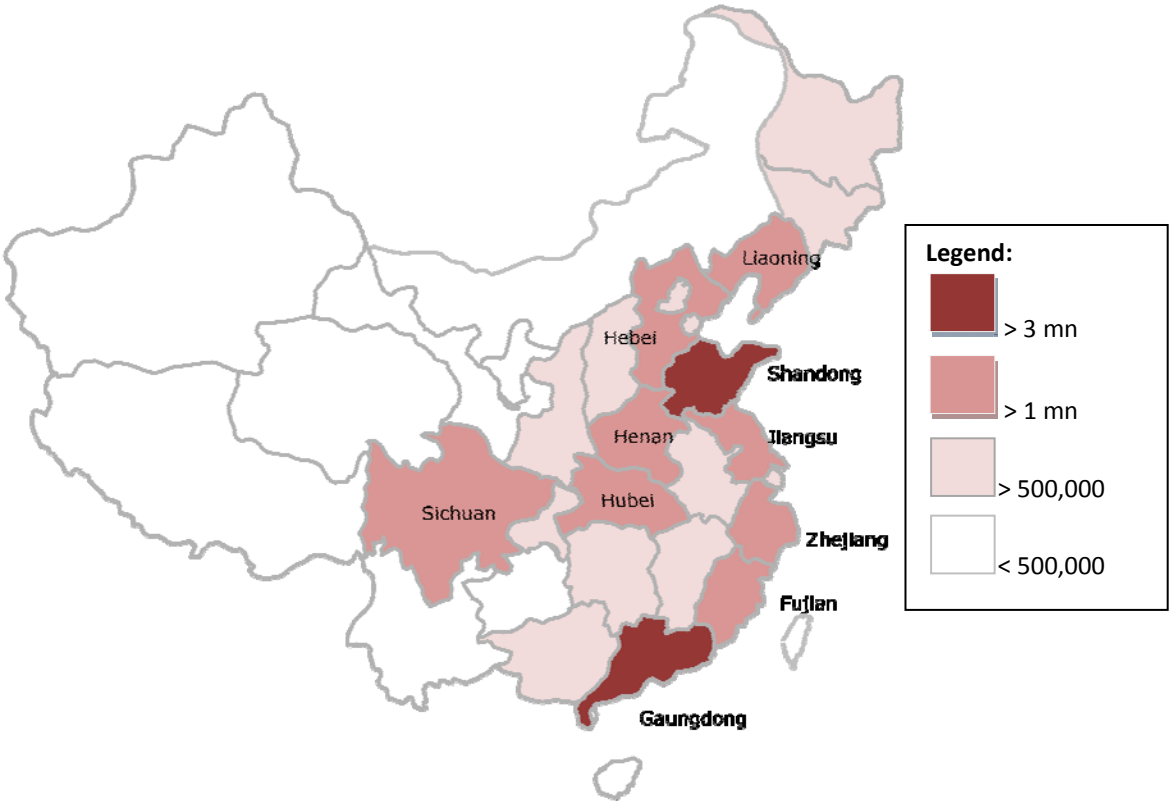
high as 46% in individual cities, with a provincial average of 17.8%.[62] The effect of the recent abolition of Chinese export rebates, the introduction of stricter environmental and labour laws and the increase in the minimum wage have all added to production costs. The 2008 Labour Contract Law is the latest in a string of labour law revisions, with harsh penalties for employers and business concerns regarding labour market flexibility. If phenomenon such as this continues in other provinces it could erode one of China's key advantages towards producers in developed countries.

Within China state-owned enterprises account for as much as 20% of machinery subsector employment (see **Figure 36**). Workers in state-owned enterprises are artificially protected from competition by state subsidies and a rigid employment structure. In 2005 3.26 million persons were employed by state-owned machinery manufacturing companies.[63] Restructuring has occurred during the past two decades, with the state share of machinery sector employment continuing to decline through significant lay-offs. Despite restructuring, in 2006 the public power-generating sector and the public non-electrical machinery industry still respectively recorded year-on-year 11.5% and 15% loss of their workforce, with a 5 year decline of 32% and 40% respectively. Despite reforms and restructuring, a large number of SOEs remain potentially unprofitable and exposed to further changes in the sector.

Further exacerbating social impact concerns in the machinery sector is its relative high geographic concentration in China (see **Figure 37**).[64, 65] While northeast regions (Heilongjiang, Jilin and Liaoning) were historically the main employers, a shift has occurred with the biggest employers now being Guangdong and Shandong, accounting together for 22% of the national workforce in 2005. Among the north-eastern 'Rust-belt' provinces, only Liaoning remains an important employer with 1.45 mn workers. Other important hubs of employment are located on the coast, from Hebei to Fujian, or in the central provinces of Henan, Hubei and Sichuan. This confirms that the restructuring of the manufacturing industries did not happen independently in each province, but rather contributed to relocate industries to the coastal areas which emerged economically in the 1980s.

62 Zhu, Yan. A Substantial Increase in China's Minimum Wage, Fujitsu Research Institute, 11 Jan 2007
63 The figure for electrical machinery is estimated with the assumption that the share of SOEs in the total workforce was 20% in 2005, similar to 2003 (the latest available figure).
64 The absence of data on employment by province in the machinery sector resulted in analysis for the workforce in the manufacturing sector, 30% of which were employed in the machinery sector in 2005 (China Statistical Yearbook, 2006)
65 Hong-Kong SAR, Macau SAR and Taiwan are not included in this study.

Figure 38: Workforce in the manufacturing sector by Chinese province – 2005



Source: China Statistical Yearbook (2006)

2.2.2 Other Social Issues

Employment considerations should also address the issue of 'decent work'. The International Labour Organisation (ILO) has defined decent work as a "decent and productive work, (practiced) in conditions of freedom, equity, security and dignity". The ILO places emphasises on worker dignity, calling for a recognition that labour activities have co-benefits beyond just its contributions to output productivity growth.

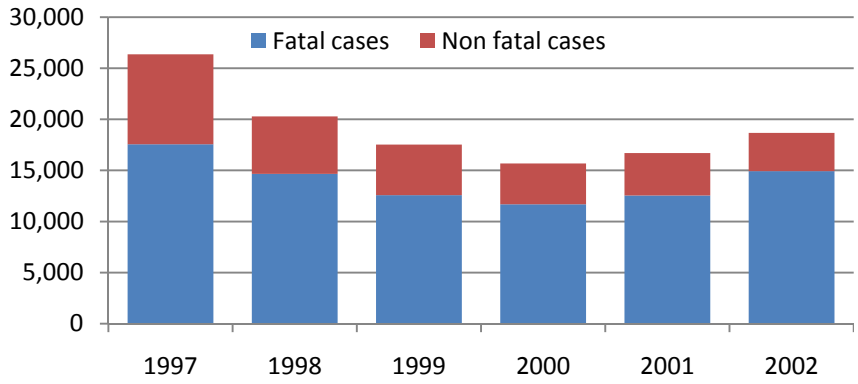
This analysis will focus on safety at work, a key pillar of 'decent work' as defined by the ILO. Every year around the world, 350,000 persons die from work fatalities and 1.7 million from work-related diseases, a figure which emphasises the importance of improving work safety issues.

Situation in China

Workplace accidents in China declined significantly between 1997 and 2000, however, a gradual rise since 2000 (including in fatal accidents) has raised doubt as to the actual long term trends in China's work safety environment (see **Figure 38**). Since 2000 the number of accident total cases increased by 20% to reach 18,679 in 2002, driven predominantly by a surge in fatal cases. While mining accounts for the majority of workplace accidents in China, the manufacturing sector ranks second with 38% of total casualties (4,384 cases)

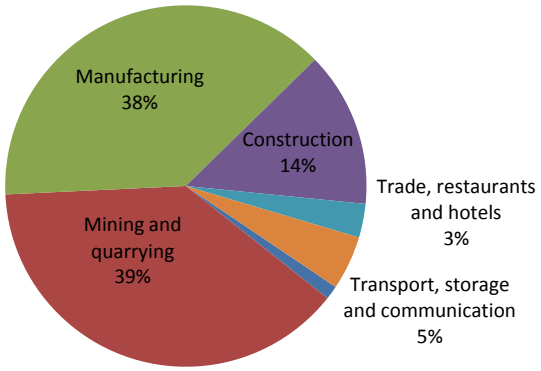
in 1997 (see **Figure 39**).[66] Other sectors lag behind, with only construction having a significant share (14%) of national figures.[67]

Figure 39: Total work injuries in China



Source: Laborstat (ILO database)

Figure 40: Workplace injuries by sector in China 1997



Source: Laborstat (ILO database)

It is important to note that these figures are surprisingly low, with casualty rates in China at 2.5 per 100,000 workers in 2002 for the whole economy, well below European levels.[68] This figure is low despite a number of qualitative reports and anecdotal evidence showing that safety in the workplace is particularly poor in China. Companies are generally not keen to report high figures that would demonstrate their poor compliance with safety measures and prefer to solve problems internally through informal indemnifications. In addition, local officials may not have an interest in reporting poor compliance by companies they are charged to monitor (and sometimes have an interest in). The legal sanction for workers to organise independent unions also contributes to limited transparency on work safety in China. Recently, however, the commitment of central authorities to work safety has been extended, with the enactment of the Regulations on Reporting, Investigation, and Handling of Accidents Disrupting Production Safety, which came into force in June 2007.

In addition to casualties, Chinese workers' health and safety is endangered by poisoning from the use of chemicals. Protection such as masks, booths that limit the spread of sprayed chemicals, proper ventilation systems as well as safety rules are often lacking or insufficient, exposing workers to levels of toxins far beyond permissible doses.[69] The Chinese Ministry of Health acknowledged in 2005 that 200 million of Chinese workers were routinely exposed in factories to toxic chemicals and 'life-threatening diseases'. Government data for the same year reported 368,645 deaths related to occupational illness, a figure that does not include the millions of persons living with fatal diseases caused by factory work.[70] Foreign-invested enterprises, faced with increasing pressure to ensure acceptable working conditions in their subsidiaries and suppliers' factories in China, find it difficult

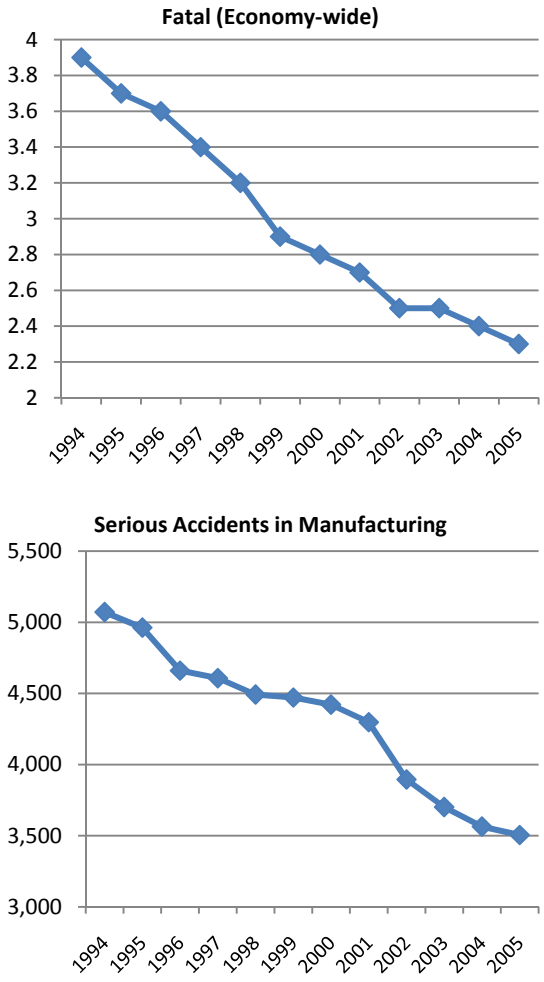
66 Laborstat
67 Which are likely to be underestimated given the large number of non-registered migrant workers in the sector.
68 4.45 per 100,000 workers (estimated by calculating the ratio number of fatal occupational accidents / workforce in the EU)
69 Ibid.
70 Journal of Epidemiology, 14 July 2006 (Chinese government data compiled by the ILO)

to improve safety without increasing manufacturing costs and controls to check factories' conditions are generally ineffective.[71]

Laws and regulations to protect worker rights and safety exist in China but have inconsistent enforcement. China's 2002 Occupational Disease and Prevention Control Act is considered to be as strict as 'western' regulations on limits of workplace poisons, but suffers from lax enforcement: scientific studies still found higher than allowable levels of toxic substances such as benzene or lead in the factories after the law was enacted.[72] More recently, the State Council Work Safety Committee has deemed 2008 to be the "hazards-control year", insisting on the government commitment to fight illegal activities and immoral officials' behaviour, and calling for greater supervision in order to lower the risks faced by workers nationwide.[73]

The capacity of workers and their dependent families to cope with the consequences of workplace accidents is still minimal in China. Insurance financing medical care or covering the income shortfall resulting from a workplace accident could in part mitigate the social consequences of problems related to work safety. In 2007, however, only one Chinese worker in seven was covered by injury insurance, highlighting the environment of risk, physical and financial, which workers and their dependents experience due to poor workplace safety.[74]

Figure 41: Accidents at work: incidence rate in the EU15 (per 100,000 workers)



Source: DG Employment, Social Affairs and Equal Opportunities

Situation in Europe

Workplace safety is an issue of crucial importance for Europe's 200 million workers. Although workplace safety statistics for Europe are significantly better than the world average, the number of casualties in absolute terms remains a concern: every year, more than 4 million accidents occur at work in the EU, killing 8,900 persons, forcing more than 350,000 to change jobs, disabling 300,000 to different degrees and excluding 15,000 from the labour market permanently.[75] In addition, work-related diseases are responsible for 142,000 deaths each year.

Fortunately, workplace accidents in Europe are clearly on a downward trend for both fatal accidents and serious accidents in the manufacturing sector (see **Figure 40**).[76] Furthermore, the European Union has set new ambitious targets

71 Ibid. The manufacturing process of cadmium batteries (a machinery good) is regularly blamed for exposing workers to high levels of cadmium, which potentially cause kidney failures, lung cancers and bone diseases. Several foreign invested utilities would be involved, such as a Panasonic cadmium-batteries plant in Wuxi (see "Toxic Factories Take Toll on China's Labor Force", Wall Street Journal, 15 January 2008).

72 Ibid.

"Chinese workers lose their lives producing goods for America", The Salt Lake Tribune, 2007

73Li Yizhong, Minister of the State Administration of Work Safety (SAWS), speech at the Press Conference of the State Council Information Office, 22 January 2008.

74 104 million workers covered by the end of March 2007. Source: China Industry News, 27 April 2007.

75 2007 figures for EU25, DG Employment, Social Affairs and Equal Opportunities

Interview with Vladimir Spidla, EU's Commissioner for Employment, Social Affairs and Equal Opportunities, European FORUM of Insurances against Accidents at Work and Occupational Diseases, Forum News, N. 28, November 2007.

76 "Fatal accident: an occurrence in the course of work leading to death within one year of the accident. This includes accidents in the course of work outside the premises of one's business, even if caused by a third party, and cases of acute poisoning. It excludes accidents on the way to or from work, occurrences having only a medical origin, and occupational diseases. Fatal road traffic accidents and other transport accidents in the course of work are also excluded." DG Employment, Social Affairs and Equal Opportunities

in the 2007-2012 Health and Safety at Work Strategy, aiming for a 25% reduction in the number of accidents at work and occupational diseases per 100,000 workers by 2012.[77]

Progress is also occurring in the manufacturing sector, often seen as more dangerous than the average. Between 1994 and 2005, the number of serious accidents per 100,000 workers decreased by more than 1,500 cases, a 30% decline. Following a slowing of the rate of decline between 1998 and 2001, reductions progressed with a 20% improvement in casualties in the following four years, demonstrating the capacity of EU manufacturers to continue to achieve progress beyond already high levels of work safety.

Unfortunately progress in the reduction of work-related accidents has not been consistent across all EU countries. On average the EU experienced a decrease of 22% in the number of serious accidents at work between 1998 and 2005, one third of the Member States showed lower performances. [78] In some Member States' the incidence rate has barely decreased or even increased over the period (see **Table 8**), highlighting the (relatively) high exposure of workers to safety problems in these countries.

Table 8: Serious accidents at work for select EU countries

	1998	1999	2000	2001	2002	2003	2004	2005
Estonia	100	106	105	132	125	128	124	126
Lithuania	100	97	94	85	86	82	82	104
Ireland	100	100	100	100	100	105	94	101
Netherlands	100	108	105	92	100	82	73	100
Cyprus	100	100	112	112	92	103	103	97
Romania	100	100	106	113	104	111	103	96
Latvia	100	75	66	116	108	84	79	92
France	100	101	102	98	99	95	90	90
Spain	100	107	108	106	103	100	92	87

Source: DG Employment, Social Affairs and Equal Opportunities
Note: per 100,000 persons, 1998=100

Insurance schemes protecting European workers against the consequences of work-related casualty or disease are generally evaluated as satisfactory even if they differ significantly across countries.[79] Differences lie mainly in legal supervision of occupational risk financing, risk rating systems and the role of the insurer in risk prevention. A common base has been established for most insurance schemes in Europe: occupational disease and injury insurance remains a specific form of social insurance, funded by the employer who takes responsibility for risks inherent in the business activity, and managed by an organisation dedicated to occupational risk.[80]

"Serious accident: an occurrence in the course of work that leads to physical or mental harm with more than 3 days' absence. This includes accidents in the course of work outside the premises of one's business, even if caused by a third party, and cases of acute poisoning. It excludes accidents on the way to or from work, occurrences having only a medical origin, and occupational diseases." DG Employment, Social Affairs and Equal Opportunities
77 European FORUM of Insurances against Accidents at Work and Occupational Diseases, Forum News, N. 28, November 2007.
78 DG Employment, Social Affairs and Equal Opportunities, for the EU27.
79 Casualty Special Update, Guy Carpenter, September 2006.
80 Ibid (with the exception of UK, Ireland, France and Sweden)

Despite large EU gains in work safety, problems remain with the reintegration of previously injured employees. Workers excluded from the workplace for a extended periods of time due to work accidents, occupational illness or a disability, often find it difficult to find re-employment. The EU, in its Community Strategy 2007-2012 on health and safety at work, encourages Member States to incorporate specific measures into their national strategies such as financial assistance and training tailored to individual needs in order to improve rehabilitation and reintegration of these workers. [81]

81 Vladimir Spidla, EU's Commissioner for Employment, Social Affairs and Equal Opportunities, in an interview with the European FORUM of Insurances against Accidents at Work and Occupational Diseases, Forum News, N. 28, November 2007.

2.3 Environmental Significance

The machinery industry has a complex inter-relationship with the environment. Like all industries, it impacts the environment through its production processes, i.e. the resources used, the energy consumed and the pollutants emitted, with the possibility of this being mitigated by flanking measures such as cleaner processes, reduction of industrial waste and limitation of water use. Furthermore, machinery produces goods used by other industries as inputs to their own production processes. The quality of the equipment produced therefore has an impact on the environment through contribution to these industries' output. Additionally, as a consumer good, machinery's impact on the environment is felt through the use of the product by the consumers. The first part of this analysis will focus on the environmental significance of the upstream production process of the machinery industry, while the second part will detail the downstream impacts.

2.3.1 Production and upstream markets

Production processes: energy consumed, emissions, wastes, water use

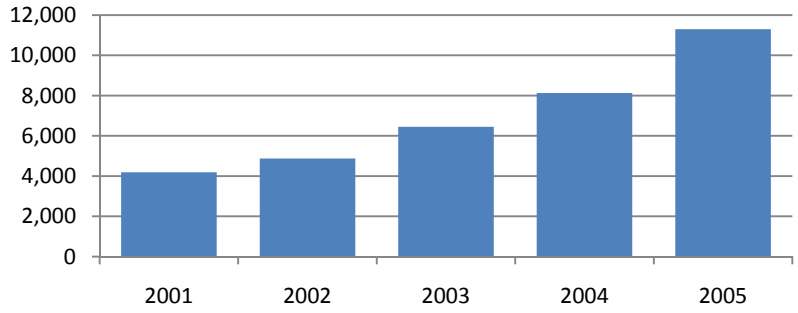
The most direct impact the machinery sector has on the environment is through its production processes. Like other industries, machinery emits a certain quantity of pollutants while it manufactures equipment. The EU's 1997 Engine Emissions Directive, in charge of setting environmental objectives for the machinery industry in Europe, targets the following pollutants: nitrogen oxide and particulate matters, nitrous oxide, volatile organic compounds, particulate matter and CO2.

For China, it is possible to quantify the CO2 emitted by the machinery industry through recent studies that have highlighted the share of pollution in China that is linked with the production of goods imported by European countries.[82] In the case of Norway this price was estimated for machinery at 0.291 Norwegian crowns (NOK) (€0.036) per kilogramme CO2, which place machinery in the category of "CO2-intensive products".[83] Utilising a similar methodology reveals that the CO2 emitted by the machinery industry in China has grown rapidly since 2001, exceeding 10,000 tons of CO2 annually by 2005 (see **Figure 41**).

82 Reinvang & Peters; Norwegian consumption, Chinese pollution; Industrial Ecology Programme at the Norwegian University of Science and technology, January 2008.

83 This definition of machinery differs slightly, including "standard machinery and equipment, plus electric appliances, computers, office equipment, and so on" See their study for more details on the methodology used and the assumptions made. We used the following exchange rate to calculate CO2 emissions per US$ in 2001: 1 US$ = 8.9 NOK (www.oanda.com).

Figure 42: Machinery Production Emissions in China (tons CO2)



Source: Reinvald and Peters (2008); China Statistical Yearbook (2002 to 2006)

Demand of inputs

The machinery industry also has upstream impacts on the environment, through its demand for inputs. The fast economic development of the sector has provoked increasing needs, especially for raw materials such as iron, copper, aluminium and high-quality special materials.[84] The environmental impact of mining and metal-processing industries can be partly linked with (if not attributed to) the development of the machinery industry.[85]

2.3.2 Downstream markets and final goods

Downstream, i.e. as inputs of other industries

The machinery sectors downstream clients have environmental impacts in their production and consumption processes in addition to the machinery sector's direct impacts. Industries today increasingly feel the pressure to adopt more energy-efficient production processes, in order to cut rising costs and to mitigate their environmental footprint. As a result, operators have had to adopt environmentally sound practices due to their status as major energy consumer and CO2 emitters, with ongoing pressure exerted by stakeholders: public opinion, NGOs, governments, international organisations and even sometimes the companies' own shareholders. The degree of technology and the efficiency of machinery equipments used during the production process of industries contributes to address the combined problems of resources scarcity, soaring energy prices and environmental protection.

The European Union historically produces machinery goods and equipment more efficient than in other parts of the world, encouraged by higher technical standards and by increasingly demanding consumers. Within the EU, Germany – the biggest producer of machinery – leads in the design and production of more energy-efficient products. The German Government has launched several energy saving projects with the EC that aim at inspiring more initiatives in the future.[86] Within the machinery sector, the machine-tools industry is

84 Draft Global Analysis Report on Trade SIA, Emerging Market Group (EMG) & Development Solutions, August 2007
85 The machinery industry represents 26% of the Chinese industrial output. Source:
Draft Global Analysis Report on Trade SIA, Emerging Market Group (EMG) & Development Solutions, August 2007.
86 The Sector Association Machine Tools and Manufacturing Systems; 15 Feb 2008. www.vdma.org

performing well, even pre-empting related EU regulations, and should be followed by the machine construction sector.[87]

In China, energy inefficiency in industry is alarmingly high, although the first results of recent proactive policies may soon become visible. Chinese industries still need 3.5 times more energy to produce the same quantity of output as European industries, with no clear downward trend.[88] China's industrial sector is dominated by large State-Owned Enterprises (SOEs) that, despite reforms and restructuring, remain inefficient and highly polluting. According to the China Sustainable Energy Program, Chinese industry emits "the bulk of China's pollution" and consumes 70% of the country's primary energy, with almost half caused by the 1000 most energy intensive companies.[89] It is reasonable to assume that the equipment used is partly responsible for this problem, with some machinery equipment showing relatively low energy consumption performance.[90]

The Power Industry

The power-generating equipments sector has a direct impact on the environment through the energy used and the pollution emitted to produce the equipments. In addition to representing a financial cost and an economic burden, the problem of inefficiency in the power industry contributes to further degrade China's environment by using a huge quantity of energy to fuel the economy. As explained above, many culprits are to be blamed for this: poor management, irrational energy structures, important losses in power transmission, inadequate market mechanisms, low quality power-generating equipments, etc. If it is not possible to break down the environmental impact of each factor, the level of technology and efficiency of the equipments producing energy plays a great role in this process. In a December 2007 report the NDRC describes 'unsatisfactory' energy technology that hinders efficiency in the power plants.[91] The 2004 Medium and Long-Term Energy Conservation report by the NDRC notes that in 2000, the average operating efficiency of coal-fired industrial boilers was around 65%, 15-20 percentage points lower than that of advanced economies, and the average energy efficiency of medium and small sized motors was 87%.

Power-generating equipment's contribution to the environmental significance of the power industry is heightened by the composition of the energy mix used in China. Thermal power (coal-fired and oil-fired electricity) accounts for the great majority of the energy produced: 83% (up from 81.5% in 2005), versus 14% from hydropower, 2% from nuclear power and less than 1% from other sources (wind power, landfill methane and biomass).[92] Energy

87 According to a statement by Mr. Carl Martin Welcker, Chairman of the German Machine Tool Builders' Association (VDW).
88 Depending on the methodology employed for measurement energy consumption in China is rising or at best stabilising
89 Fact Sheet: China Emerging as New Leader in Clean Energy Policies; The China Sustainable Energy Program, 2007.
90 In 2000, according to the 2004 Medium and Long-Term Energy Conservation Plan, "average energy efficiency of medium and small sized motors was 87%, the average design efficiency of fans and water pumps was 75%, all being 5 percentage points lower than that of advanced world level, with the system operating efficiency nearly 20 percentage points lower"
91 NDRC, *China's Energy Conditions and Policies*, December 2007.
92 2006 figures; source: USA Department of Commerce online, http://www.buyusa.gov/china/en/power.html
Efficiency Improvement and Energy Conservation in China's Power Industry, Zhang Anhua, Zhao Xingshu, United Kingdom Treasury Working Paper.

production from non-thermal energy sources is rising in absolute value, but at a lower rate than total energy generation. Coal remains a dominant source, with its consumption being the main cause of smoke pollution and GHGs emissions in China (see **Table 9**). The degree of technology used in coal plants plays a significant role in the quantity of energy used and emissions produced. State of the art coal plants – or "super-critical stations" – convert 42% of the energy used into electricity and are 12% more efficient than older 'sub-critical' plants.[93] 20 units are installed throughout the country and a large number of others are under construction. "Clean coal" technologies using coal gasification or carbon capture also contribute significantly to limit emissions, but are yet to be adopted.[94]

Table 9: Total and per unit of electricity emissions of pollutants (2004)

	Total(million tons)	Unit emission rate(g/kwh)
SO2	12.0	6.63
NOX	6.5	3.59
Soot emissions	2.75	1.52

Source: Efficiency Improvement and Energy Conservation in China's Power Industry, Zhang Anhua, Zhao Xingshu, United Kingdom Treasury Working Paper.

Renewable energies are gradually developing in China, with wind power capacity doubling in 2006 due to active support from the NDRC.[95] The solar photovoltaic industry is also enjoying outstanding growth (6 fold between 2004 and 2005, third position in the global market).[96] To encourage the use of renewables, China has enacted the Renewable Energy Law (effective February 2005) which sets ambitious and legally binding targets, plus a number of other policies including special taxes to support the development of renewable energy and a favourable 'feed-in' tariff applied to electric utilities for the output of renewable facilities).[97] Despite these considerable efforts, renewable energy still accounts for a tiny share of the energy mix, lagging behind developed countries and even some developing countries such as India. Wind power generation capacity for example accounts only for 1 GW, a third of wind-capacity in India. The relative cost of this energy source is an obstacle, the cost of wind power being 50% higher than coal-fired plants. However, it is estimated that if external costs are taken into consideration, coal power becomes 50% more costly than wind power, which highlights the interest in developing renewable energy in order to ensure sustainable development.[98]

Final goods

Most of the goods included in the machinery sector are inputs to be used by other industry sectors, however, a certain number of them are final goods, such as household appliances like washing-machines, refrigerators, dishwashing machines, shavers, lamps, batteries and accumulators.

93 Coal-fired power heats up China, Rowan Callick, The Australian Business, 17 March 2008
94 Ibid.
95 Fact Sheet: China Emerging as New Leader in Clean Energy Policies; The China Sustainable Energy Program, 2007
96 Lewis, Joanna. 'China's Strategic Priorities in International Climate Change Negotiations.' The Washington Quarterly. Winter 2007-08
97 Fact Sheet: China Emerging as New Leader in Clean Energy Policies; The China Sustainable Energy Program, 2007
98 Ibid.

In the EU, energy demand resulting from household products accounts for 25% of final energy needs, with electricity used for domestic appliances showing the largest growth.[99] Higher living standards, multiple purchases of electric appliances and a growing demand for air-conditioning devices drive this upward trend. The quality of equipment is also important: the use of obsolete and energy-inefficient appliances has a heavy environmental cost, with at least 44 Tera Watt hours of energy waste per year in the EU due to inefficiency.[100] Nonetheless, important progress has been made in recent years, both on product efficiency and EU regulations: over the last decade, sizeable investments in the sector exceeding €10 bn has bolstered energy efficiency from 15% for water heaters to as high as 40% for refrigerators and freezers, resulting in an actual reduction of energy consumption of 12%.[101] Energy labelling and policies setting minimum efficiency requirements also contributed significantly to these achievements, with 12 EU Directives in the last 15 years covering these areas.

In China while the share of household equipment may not yet reach EU levels, the country represents the largest growth market in the world in this segment, remaining far below saturation levels. Rising incomes and a boom in the housing market have resulted in soaring demand for refrigerators, air-conditioners and water heaters, with a great majority produced by local manufacturers.[102] Energy efficiency regulations for household appliances have existed since the late 1980s and have been expanded to cover more products and raise the stringency of performance levels. However, even the most recent energy efficiency requirements standards implemented in 2007 still lag significantly behind developed countries.

The environmental significance of household appliances is particularly high in China, a problem that stronger regulations and standards could prevent. China, as a leading exporter of household appliances worldwide, spreads the environmental significance of Chinese-made appliances to its export markets, implying that improvements in efficiency in China could have important (positive) spill over effects. Conversely, increased Chinese exports of inefficient products would induce a greater impact on environment in recipient countries.[103]

99 European Commission, DG for Energy and Transport.
100 "Eco-efficiency of Household Appliances"; Presentation by Luigi Meli, Director General of CECED 27 March 2006
101 Ibid.
102 "Mitigating Carbon Emissions: the Potential of Improving Efficiency of Household Appliances in China"; Jiang Lin; Environmental Energy technologies Division; Berkeley National Laboratory; July 2006
103 Ibid

2.4 Future Directions

2.4.1 Economic Forecasts

In the past decade, the size of the machinery sector in Europe and in China has dramatically increased to reach historic levels, with outstanding growth in production and trade. Baseline economic forecasts for the years to come predict a continuation of this trend, with sub-sectors differences between the EU and China.

Although the power-generating equipment sector does not represent the largest market share of machinery in China it is likely to see the fastest growth, spurred by surging power demand. The projections for electricity demand and supply capacity for the years to come highlight the importance of this growth: by 2020, demand is expected to nearly double to reach 5.1 trillion kWh while production capacity will increase by 70% up to 970 GW (coming mainly from coal, but with a growing share of hydro power).[104] Other studies estimate the investment in energy-supply infrastructure to amount to US$3.7 trillion over the period 2006-2030.[105] Improvements in the power generation process (which are affected by the quality of the equipment) and in power transmission are expected to raise efficiency in the power industry, bringing it close to the OECD average.

Demand for quality, energy efficiency and renewable energy-related equipment will increase as the need to increase energy efficiency in Chinese industries intensifies. While Chinese producers are gaining ground in the high-tech segments of machinery, EU producers are likely to remain competitive if they maintain their drive for innovation and high quality niche products. With this in mind European sales in China are expected to surge by 10% per annum until 2010.[106]

There is no clear consensus on the question of import substitution in China. Domestic production, exports and imports will all keep growing, even if at a lower rate than in recent years. Uncertainty remains, however, regarding the speed at which each will grow. While current strategies should result in a trade balance in the immediate future (2008-2010), different alternative scenarios are foreseen.[107] The drive to reach a trade balance and boost import substitution will mainly depend on the growth of FDI (and thus of FIEs' output) and its effect on the local market. If it remains as high as it is now, the local market will remain overcrowded and domestic producers will pursue export strategies, leading rapidly to balanced trade. If the flow of FDI slows, the output by FIEs will grow more slowly, resulting in lower market pressure on domestic companies. In this situation, the shift to international markets will not be as clear and imports will take more time to catch up with exports. Under each scenario, import substitution trends are expected to be visible in relative terms – i.e. imported machinery share in domestic consumption will shrink – but the Chinese market will still require imports of high-tech equipment.

104 Efficiency Improvement and Energy Conservation in China's Power Industry, Zhang Anhua, Zhao Xingshu, United Kingdom Treasury Working Paper
105 "Norwegian Consumption Chinese Pollution"; WWF's Trade and Investment Programme and the Industrial Ecology Programme at the Norwegian University of Science and Technology; 14 January 2008
106 CEIBS, April 2007. http://www.ceibs.edu/knowledge/strategy/17571.shtml
107 Ibid.
"Machinery sector: forward-looking perspective of EU-China trade and investment relations", DG Trade working paper, 2006. http://trade.ec.europa.eu/doclib/docs/2006/july/tradoc_129427.pdf

2.4.2 Legislative Environment

Situation in China

Despite economic opening and gradual liberalisation, domestic policies and regulations still have a significant influence on the machinery sector in China. Even with further development in the Doha Round or bilaterally, unilateral decisions or domestic regulations on trade and investment will constitute the main driver of the industry's policy environment.

China's Eleventh Five-Year Programme (5YP 2006-2010) is the main piece of legislation, aiming to pave the way for the economic policy over this period. [108] The 5YP provides direction for government priorities and the policies it is likely to lead in the sector. Several other regulations and policy documents also inform the future development of the machinery industry, such as the "Catalogue for the Guidance of Foreign Investment Industry".

The Eleventh Five-Year Programme (2006-2010) and related Medium to Long-Term Development Plans (2020)

Industry-wide:

An important 'flagship' measure of the 11th 5YP concerns energy efficiency with energy consumption by unit of GDP to be reduced by 20% from 2006 levels by 2010. This is a response to the high level of energy consumption in China, which causes significant waste and has a growing economic cost. This target comes in addition to the Medium and Long-Term Energy Conservation Plan issued by the NDRC (effective since November 2004) that also sets energy efficiency targets for 2010 (reduction by 16% from 2002 levels), and 2020 (reduction by 42% from 2002 levels, to 1.54 tce per KYuan GDP). However, statistics after the beginning of the 11th FYP have not shown a clear downward trend in the consumption of energy per unit of GDP, with 0.8% growth in the first half of 2006 and a 2.78% decline in the first half of 2007 compared to the same period the year before, far from the annual target of 4.4% reduction necessary to achieve the 2010 20% reduction goal. However, some official sources predict that China could meet this annual goal for the first time in 2008.[109]

Power Industry Specific:

If the industry as a whole has to reduce its energy consumption per unit of output, targets are also set on the supply side: by 2010, energy supplies will have to "basically" meet the "demands of economic and social development".[110] General objectives are set in the field of energy efficiency and conservation, and all the problems inherent in the power supply sector will have to be addressed, in a way that is "compatible with the socialist market economy". Besides efficiency, the 11th 5YP also encourages the development of 'cleaner energy'. The NDRC also pushes for a greater use of price and fiscal mechanisms to encourage energy conservation. The overall goal is to ensure a sustainable development of the sector that meets demand and benefits society and the environment. The projections for the coal consumption per unit of electricity, if attained, should bring China close to the OECD average (see **Table 10**).[111]

108 The term "Plan" has been replaced, for the first time in the history of the People's Republic of China, by a term that in Chinese means "Programme", "Planning" or even "Guidance", a symbolic move that is seen as an official recognition of the change in the role of the State in the economy.

109 According to Fan Jianping, Director of the Economic Forecast Division of the State Information Center (a state-backed think-tank), in prepared remarks for a speech on 26 February 2008

110 NDRC Energy report December 2007

111 Efficiency Improvement and Energy Conservation in China's Power Industry, Zhang Anhua, Zhao Xingshu, United Kingdom Treasury Working Paper

Table 10: Major indices for Chinese power industry in 2010 and 2020

	Coal Consumption per unit of electricity (g/kWh)	Internal use of electricity as % of total generation	Power transmission losses %
2005	374.00	5.82	7.18
2010	360.00	5.50	6.65
2020	320.00	5.10	6.20

Source: Medium and long term energy plan, 2005—2020; 11th Five Year Plan, NDRC related documents

For renewable energies the NDRC set ambitious goals in terms of production capacity in the Medium and Long-Term Renewable Energy Development Plan launched in August 2007: by 2020, installed capacity for small hydropower utilities, wind, biomass and solar are to reach 75 GW, 30 GW, 30 GW and 1.8 GW respectively.[112] These objectives will require tremendous investment, estimated to amount to nearly US$270 bn and likely to represent a surge in the demand of renewable energy generating equipment.[113] These developments have been welcomed, and provide a catalyst for China's development of a comprehensive, complete energy law.[114]

Machinery Industry Specific:

In line with the 11th FYP, the State Council made an announcement on 23 February 2006 on "Revitalising Machinery Industry", with objectives to attain by 2010. The State Council sets priorities and details government interventions that are designed to overcome low levels of innovation, dependence on foreign technology, "unreasonable" industrial structure, and "insufficient" international competitiveness. Among the main priorities that will benefit from state support are: the share of large-scale enterprise, equipment productivity, independent IPR, supply of energy and raw materials, national R&D facilities and specialisation in the industry. In addition, the government intends to bring its political and institutional support to selected projects of core importance, selected by their contribution to national defence; economic security; sustainable development; or the industry's upgrading / balanced structure. In its proposal for the 11th FYP, the Chinese Government also calls for support of the development of a balanced industry, with a focus on new and high technologies. Among the industries encouraged, machinery is a major component, with a call to realise breakthroughs in "high efficient and clean power generating units and transmission equipment, high-grade numerical-control machine tools, equipment for automatic control and integrated circuits, and advanced power devices."[115]

The Catalogue for the Guidance of Foreign Investment in Industry 2007

The Ministry of Commerce of China and the National Development and Reform Commission (NDRC) regularly publish a list of the industries whose development is 'encouraged', 'restricted' or 'prohibited'. The latest version of this list, the 'Catalogue for the Guidance of Foreign Investment Industry', is effective as of 1 December 2007. The purpose of this catalogue is to provide foreign entities with an official indication of sectors where the government seeks to receive more investment from abroad, and others where it does not, because domestic entities have already mastered the necessary technology and have a strong production capacity. The 'prohibited' investments category gathers industry sectors where the Chinese government does not wish to receive FDI. Industry sectors that are not included in this Catalogue are

112 Hydropower is not considered as a renewable energy, except when it involves small utilities.
113 Fact Sheet: China Emerging as New Leader in Clean Energy Policies; The China Sustainable Energy Program, 2007.
114 USA Department of Commerce online, http://www.buyusa.gov/china/en/power.html
115 Xinhua News Agency; 17 October 2007.

considered as 'permitted', and the fact that they do not appear in the list reveals a neutral attitude toward them, neither encouraged nor discouraged.

Almost all the sub-sectors that compose the machinery industry in this study are classified as 'encouraged' by the NDRC and MOFCOM, with only a few very particular types of equipment 'restricted'.[116] This positive 'signal' sent by the government to foreign investors does not necessarily mean that FDI will not face barriers or restrictions. It rather signifies that China seeks to attract a greater quantity of them, according to its own interests and strategy.[117]

Market Mechanisms Reforms:

As the 11th FYP provides the main policy guidelines for the sector, and the Catalogue for Foreign Investment indicates the official attitude towards FDI, there are also more concrete measures and programmes that contribute to shape the business environment of the machinery sector.

Different markets in the machinery sector, or in related industries, are undergoing a set of reforms, such as the market of power, which has a direct impact on the power-generating machinery. Since June 2006, the NDRC has established an adjustment programme on the price of electricity that has resulted in an increase of the national average sale price by 0.025 RMB/ kWh. This market adjustment has been made to improve the economic significance of energy prices by taking into account the increase of coal price and the relatively high cost of renewable energy. Furthermore, this move is also supposed to cover the costs of the desulphurisation of power plants and to cope with the financing shortage of power grid construction.[118] A better price mechanism for the power industry would allow this sector to raise its profitability and realise its full potential, resulting in a higher demand of inputs such as power-generating equipment.

Regional Focus

In addition to national policies or regulations, the authorities also have regional plans tailored to achieve local objectives. In December 2007, the NDRC's "Office of the Leading Group for Revitalising Northeast China and Other Old Industrial Bases" released a "Plan of Revitalising Northeast China", in line with the guidelines of the 11th FYP, but with an outlook to the year 2020.

The first important objective of this plan concerns the building of a base for "manufacturing advanced equipment", especially priority sectors such as heavy machinery like digital machine tools, set equipment for oil refining or chemical processing of coal, large metallurgical equipments, power generation and transmission equipments and construction equipment.[119] The Plan highlights the importance of R&D and innovation to make the equipment manufacturing industry in the Northeast internationally competitive, with a state investment in R&D in the strategic segment of power-related equipment. Platforms to foster independent innovation will be established and provincial

116 Crawler dozer of less than 320 horsepower, hydraulic excavator of less than 30 tons, wheel loader less than 6 tons, grader less than 220 horsepower, road roller, fork-lift truck, non-calzada dumper truck, road surface milling rework machinery, garden machines and tools, production of commodity concrete machinery (pump, agitating lorry, pump vehical).

117 The fact that the vast majority of the sectors listed fall into the 'encouraged' category diminishes the importance of such a classification for the machinery sector. It is plausible that realities will differ largely for different 'encouraged' industry sectors.

118 Efficiency Improvement and Energy Conservation in China's Power Industry, Zhang Anhua, Zhao Xingshu, United Kingdom Treasury Working Paper, 2006. The Plan's document understands North-East China as including the following: Liaoning Province, Jilin Province and Heilongjiang Province as well as Hulunbeier City, Xinggan League, Tongliao City, Chifeng City and Xilinguole League, the latter five areas located in the eastern part of Inner Mongolia.

119 Notably in Daqing City

governments are requested to increase their financial commitment and support to the commercialisation of SMEs' technical progresses.

Related industries are also in the focus of this Plan, with objectives comparable to the ones existing at national levels in the case of the energy industry. Coal-powered chemical industrial bases as well as crude oil production capacities are to be developed and regional cooperation with other countries to be pursued.[120] Agriculture is another sector addressed with the Plan encouraging further investment, notably the purchase of agricultural machinery, in order to achieve the advancement of agricultural sciences and technology, and to raise productivity.

According to the Plan, the central authorities will also make a commitment to public responsibility by supporting employment and improving the social security system in the Northeast region. In particular, development of labour-intensive industries will be supported; at least one job opportunity will be secured for families with no one employed and self-employment will be encouraged. The Plans highlights the need to improve the systems of basic pension and medical insurance in urban areas, as well as unemployment insurance, work injury insurance and maternity insurance.

Situation in Europe

The policy environment in Europe is radically different from China. The political power seeks to set up an adapted framework, to create a favourable environment for the machinery sector rather than monitoring its development in an interventionist fashion. As EC President José Manuel Barroso commented, "there is no way back to the old days of protectionism and subsidies".

The main piece of European legislation is the Machinery Directive 98/37/EC, first introduced in 1989 and implemented since 1995, and to be replaced by a new one, published on 9 June 2006 and to be applied from 29 December 2009. [121] The Directive provides a regulatory basis for the harmonisation of health and safety requirements at an EU level, and applies only to the products introduced on the EU market. The first directive harmonised the standards between the EU members, thus eliminating the costs of having to comply with different regulatory frameworks (an equivalent of barriers to trade). In general, the directive has pushed European companies to improve their safety standards and production processes. The new directive will further clarify its predecessor and introduce additional technical requirements, bringing the technical standards in the EU to a superior level than in the US. Europe's focus is also on emissions with the EU's 1997 Engine Emissions Directive (amended in 2004), which calls for large reductions starting 2006, but especially after 2011 and 2014. The technical developments implied by this regulation will consist in more sophisticated engine exhaust and filtration devices, and major changes to engine/exhausts layouts.[122]

The directives of the European Union, covering 27 Member States, bind all states at a community level, however states maintain some autonomy in their

120 The Plan's objectives for energy production in the Northeast is, by the year 2010, 300 million tons of coal, 57 million tons of crude oil, 7 billion cubic meters of natural gas, 300 billion kilowatt hours of electricity with installed capacity standing at 60 MW.

121 "Machinery" here does not cover the same categories as this study but only machinery within the mechanical engineering sector as defined by the DG Enterprise and Industry: "an assembly of linked parts or components, at least one of which moves, with the appropriate actuators, control and power circuits, etc., joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material".

122 Source: "Changing EU Regulations Stimulate Machinery Innovation on View at SAMOTER", AED online, 18 January 2008.

policies, including towards industry. Due to its social significance, the machinery industry is a sensitive issue in several EU Member States.

Table 11: Impacts Summary Table Legend

(⇧)⇧	(Strong) positive impact
▫	Negligible impact
(⇩)⇩	(Strong) negative impact
⇩⇧	Mixed impacts
(+)+	(Strongly) positive existing conditions
0	Neutral existing conditions
(-)-	(Strongly) negative conditions
⌖	Localised impacts
⊙	Moderately diffuse impacts
◎	Highly diffuse impacts
L	Low capacity to change via policy
M	Moderate capacity to change via policy
H	High capacity to change via policy

Table 12: Sector Scenario Parameters

	Tariffs and NTBs reductions	Exchange Rate
	Multilateral	
Baseline with DDA	10%	-
DDA Modest	25%	-
DDA Ambitious	75%	-
Structural Change only	-	-
DDA Modest with Structural Change	25%	10%
DDA Ambitious with Structural Change	75%	10%

Table 13: Chinese Structural Change used in Projection Scenarios

Machinery	Supply	Demand
Power-generating machinery and equipment	75%	68%
Machinery specialised for particular industries	60%	53%
Metalworking machinery	66%	66%
General industrial machinery and equipment	66%	65%
Electrical machinery	65%	64%

3. PCA Scenarios

The studies in this section utilise quantitative modelling results, which are then used to qualitatively assess the impacts of a PCA between the EU and China within the themes of economics, society and environment. Finally, summary tables are provided which provide a visual guide to the overall economic, social, and environmental impacts of liberalisation specific to each sector and should be read using the legend provided in **Table 11**. These impacts are addressed in the **Final Report** with an early provision of possible flanking measures, i.e. policy recommendations, which provide negotiators and stakeholders alike with a number of potential options to address both positive and negative impacts.

Liberalisation Scenarios

While the PCA is not designed to be a means of traditional trade liberalisation, i.e. of bilateral or multilateral tariff reductions, it is possible that it may include provisions which assist with the reduction of behind the border barriers, with benefits accruing multilaterally similar to the possibility of a successful Doha Development Agenda. To simulate the impacts of this liberalisation six scenarios have been devised and applied to each sector.

Three types of medium-run experiments were run. Medium-run is taken to be a three year period during which the assumed structural changes take place and the effects of changes in the policy environment on protection and the real exchange rate apply. The first three experiments relate to shallow integration under the DDA with an unchanged real exchange rate. The three experiments shown in **Table 12** were DDA Baseline (10% cut), DDA Modest (25% cut), and DDA Ambitious (75% cut). Second, and more speculatively, a set of medium run projections of domestic demand growth and possible supply curve shift for import competing production and export production were run to obtain a consistent set of projections of imports, domestic production and domestic demand. The same supply curve shifts were applied on the export side.

PCA Impacts

The five machinery sub-sectors (power-generating machinery and equipment, specialised machinery, electrical machinery, metalworking machinery and general industrial machinery and equipment) are expected to be affected by liberalisation of the machinery sector in China. The degree of impact between the sub-sectors will not vary greatly, suggesting that they are closely related and affected similarly by liberalisation policies.

The scenario assumptions made are that barriers will be reduced by 10%, 25% u and 75% under the baseline, modest and ambitious liberalisation scenarios. The effects on the machinery sector will be more evident in the long-term,

building on the general trends that may be visible in the immediate period after liberalisation efforts. The results also suggest that the overall economic benefits in the short-term at least, are more pronounced for the EU compared to China.

Given the increasing demand for machinery and equipment in China, and the EU's comparative advantage in manufacturing sophisticated and innovative machinery and equipment, China will gain from access to these commodities. As demand increases for machinery and equipment made in the EU, it will gain from greater access to a large and growing market.

Economic Impacts

Across the five sub-sectors, liberalisation will increase domestic demand in the Chinese market (by up to 17%). The domestic supply of machinery is negatively affected, as a result of increased foreign competition in the sector. All five sub-sectors will be affected to a similar degree, though the metalworking machinery sub-sector may be affected slightly more with ambitious liberalisation resulting in up to a 5% decline in Chinese production. In an economy of China's size these numbers are significant, especially given major increases in machinery imports from EU countries. Electrical machinery imports from the EU for example are forecast to increase by up to 63% under ambitious liberalisation. These figures are substantially larger than the decrease in local supply in China. When combined with the imports from NAFTA and the rest of the world (RoW), the supply in China is outstripped by the level of imports from elsewhere. This will cause pain for some in the Chinese economy, particularly local manufacturers and suppliers of machinery and equipment.

It remains to be seen whether rapid expansion of domestic demand will drive China's machinery sector strongly in the future, or provide opportunities for international companies. China's productivity in machinery currently lags behind a number of European countries. For example, the Netherlands, Finland, Sweden and Italy, which are the most productive amongst the EU countries in this sector, out-produce China by more than five times. However, China shows immense potential as its productivity is increasing rapidly. The Chinese economy is going through a 'Heavy and Chemical Industrialisation Era.'[123] It is anticipated that the pace of this expansionary period will be one of the fastest in the world in the next 15 years.

The impact on the EU inflows of machinery from China would be dwarfed by the corresponding benefits. China would become much more dependent on imports from the EU at the expense of its local industries. This would have a negative impact on the country's national accounts. China's **economic structure** could itself be restructured as labour and resources now in the machinery sector are transferred to other sectors.

Currently, private domestic companies control about 50% of the sector, in terms of productivity. SOEs have the smallest share with around 12% and FIEs

123 Wang Mengkui, ed. Major Issues of China's Mid-long term Development (2005-2020), China Development Press, 2005
Liu Shijin, China Entered into the Period of Heavy & Chemical Industrialization Period and its Impacts on Macro Economy, on Economics Trends, 11th issue, 2004

about 30%. If China's productivity is affected by liberalisation of the sector, FIEs can be expected to gain a larger share of the market.

As exports from the EU increase as a result of liberalising the sector, trade between China and the EU will increase. Based on the figures, it appears that the trade gap will be in favour of the EU. In an ambitious liberalisation scenario, China imports from the EU will grow 65%, whereas, in the same scenario, exports to the EU will grow by only 1.5% for power-generating machinery and equipment. However, an unfavourable import-export ratio does not provide a definitive picture of the impact on the economy, as the significant levels of import growth indicates that there is a strong demand for these goods due to growth in China's economy. Given that a variety of other industries, such as textiles and construction are dependent on the machinery sector, losses in the machinery sector may be offset by growth in other industries, which require machinery and equipment. Thus, the direct productivity gains in other sectors could compensate for the losses in the machinery sector itself.

If the EU and China focused on specific sub-sectors, liberalisation would not necessarily lead to competition between the two. They could indeed become more complementary. Assuming they are both are part of the global production supply chain, China's strengths will be focused on low-end machinery; the EU's comparative advantage is in high-end machinery and equipment. Such a vertical division of labour would allow each region to build on its expertise without reducing the other's market share.

Social Impacts

Social equity recently became a policy issue in China, with major statements made in Hu Jintao's report to the 17th National Party Congress in 2007, and in Wen Jiabao's Government Work Report at the National Peoples Congress in March 2008. These interpreted the previously vague core objective of social harmony in terms of "giving increased attention to social equity and justice." Within this, rebalancing the vital indicators of China's urban and regional, and coastal and regional sectors is to be a high priority.[124]

As part of this emphasis, the Chinese leaders signalled that as well as redistributive mechanisms such as a social security net, the state should ensure social equity, and not just efficiency, in primary distribution. "Primary distribution" is a traditional category from the planned economy era, covering salaries and other direct incomes (secondary distribution covers housing, medical and other welfare-type arrangements). It is understood that different sectors of the economy have widely different salary levels for similar job classifications. These discrepancies are now acknowledged to be a major source of inequity.[125] All industry sectors under review will increasingly be

124 Wen Jiabao, "Report on the Work of the Government" (Address to the 11th National People's Congress, 5 March 2008; available at http://www.chinadaily.com.cn/china/2008-03/19/content_6549442.htm. (In Chinese), "Government work report paints road map of promoting 'social justice'," China News Net, 7 March 2008 (http://www.chinanews.com.cn/hr/ozhrxw/news/2008/03-07/1184866.shtml).].

125 Hu Jintao, "Accelerating Social Development with the Focus on Improving People's Livelihood," Part 8 of Hu Jintao's report at 17th Party Congress, October 2007; available at http://english.people.com.cn/90001/90776/90785/6290145.html.

required to monitor such social justice impacts in a policy setting similar to the social democratic frameworks of Europe. There will be a move towards increasing the share of wage incomes in the national total.

At some point with liberalisation come cuts in production of machinery and equipment are likely, thereby undermining sector employment. Job losses will follow, especially for low-skilled labour. While jobs are lost in all three scenarios, the change is less than 1%; given the size of China's economy and population, this is substantial.

Job losses aside, increased competition from the EU may also result in a downward adjustment of wages and labour standards in China's machinery sector. This will have serious consequences, especially given the currently high levels of inflation. Lowering of labour and social standards has long-term implications which will particularly affect the poor.

Furthermore, when the labour force and its wages suffer, the rural-urban divide will be exacerbated because a large part of the labour force in China that contributes to the sector is from rural areas. The EU may offer its technical assistance with mechanisms to compensate for potentially disruptive consequences of these changes.

Unemployment is a crucial problem with far-reaching consequences. Over the long-term, it reduces literacy and security. **Health** indicators, such as nutrition status and mortality are also depressed by job losses and reduced wages, especially for low-skilled labourers struggling to find employment in other sectors. The *hukou* or household registration system, which regulates population movement, is a major employment barrier, and coupled with a slow-down in the machinery and equipment sector, a variety of social problems in China may be exacerbated.

Among EU countries, Poland and Bulgaria, which had diminishing employment levels in the machinery sector, may benefit from the increased advantage of EU exports to China. Overall employment levels in the EU in this sector will improve, while the opposite will occur in corresponding Chinese regions such as Heilongjiang, which has historically been a region with substantial activity in the machinery sector.

Increased EU-China engagement affects society through the transfer of technology. Given the EU's relative strength in innovative, high quality machinery and equipment, China's technology would be upgraded through importing advanced technologies. The figures suggest an optimistic level of imports into China from the EU, ranging from 2-45% across the three scenarios. By adopting advanced technologies, China's competitiveness in the sector would improve, and in the long term, a level-playing field between the two regions could offset any initial loss of profit by Chinese machinery producers. Technology transfer into China thus offers social and economic benefit for both regions. The mounting trend for Multinational Companies (MNCs) to relocate R&D facilities to developing countries is one way in which technology and investments in this sector will enter China—already identified as a top destination for MNCs to relocate their R&D.

There is a potential barrier to importing advanced technologies due to China's relatively lax intellectual property rights protection. Could the appeal of advanced technologies propel the Chinese government to ensure stringent IPR laws and enforcement and stop exerting disguised forms of pressure to transfer technology, without which the transfer of advanced technologies into China may be deterred? This remains a key issue and is further examined in this report's Intellectual Property Rights Horizontal Study.

Environmental Impacts

One benefit of reduced manufacturing of machinery and equipment in China is that the energy use entailed by it would also be reduced. Given that China is known for its inefficient use of energy, less manufacturing would be good from an environmental perspective. In the three scenarios, China's local production is anticipated to reduce by at most 5% per subsector. However, such a reduction would not necessarily mean that the volume of machinery usage in China will be reduced, as figures suggest that import levels into China will be substantial (between approximately 1.5-17% in the three scenarios). As long as China's economy grows at the current rate and demand for machinery and equipment increases, the use of machinery and equipment will be substantial. Depending on the type and quality of machinery, it is possible that the impact on the environment will be adverse. Increasing trade volume between the EU and China in the machinery sector may entail environmental practices adopted in the EU being incorporated in China.

As a consumer good, the impact on the environment by machinery usage is also felt through the specific use of the product. For instance, machinery used in construction facilities is bound to affect **atmospheric quality,** with both short and long term implications. This is especially true of power-generating machinery. However, with appropriate flanking measures, such as cleaner processes and high quality equipment, it is possible to mitigate environmental degradation.

As income levels in China increase, changes in consumption patterns will affect the environment. With increasing consumption of household appliances—refrigerators, dishwashing machines and air-conditioners, for instance—energy demand will increase. Unless measures exist to ensure the energy efficiency of this equipment, China could face increasing environmental problems due to increasing economic growth and income levels.

Environmental regulations in the EU have generally been of a high standard. Consumer demands helped improve production processes and end products. Environmentally conscious policies relating to the machinery sector in the EU could enhance China's environmental standards, as a result of increased trade between the two regions. Given higher environmental standards in the production processes and usage relating to machinery and equipment, China would also be a more attractive destination for foreign investment as the issue of climate change becomes a priority and a determinant of business and investment decisions.

A summary of impacts is provided below. Please note that the impacts are derived from policy only scenarios, while projections scenarios help determine the feasible reversibility and capacity to change within a sustainable development theme. Refer to **Table 11** for key explanation.

Table 14: PCA Summary Impacts Table – Machinery (China)

Indicator	Existing Conditions	Scenario Impacts		Policy Options	
		Overall Direction Magnitude	Equity	Reversibility	Capacity to change
Economic					
Production (machinery)	++	⇩⇩	⊙	Y	L
Economic Structure	-	⇧	◎	Y	L
Consumption and Production Patterns	--	⇧	◎	Y	H
Social					
Equity	0	⇩	⊙	Y	H
Health	--	⇩	⊙	Y	M
Labour	-	⇩	⌖	Y	M
Environmental					
Atmosphere	--	⇧	◎	Y	M

Table 15: PCA Summary Impacts Table – Machinery (EU)

Indicator	Existing Conditions	Scenario Impacts		Policy Options	
		Overall Direction Magnitude	Equity	Reversibility	Capacity to change
Economic					
Exports & Production	+	⇧	⊙	Y	L
Social					
Labour	-	⇧	⊙	Y	M

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Annex 1 – Sector Classifications

A. SITC Rev. 3 classification of Machinery Goods

71 Power-generating machinery and equipment
711 Steam or other vapour-generating boilers, superheated water boilers, and auxiliary plant for use therewith;
parts thereof
712 Steam turbines and other vapour turbines, and parts thereof, n.e.s.
714 Engines and motors, non-electric (other than those of groups 712, 713 and 718); parts, n.e.s., of these
engines and motors
716 Rotating electric plant, and parts thereof, n.e.s.
718 Power-generating machinery, and parts thereof, n.e.s.
72 Machinery specialised for particular industries
721 Agricultural machinery (excluding tractors), and parts thereof
722 Tractors (other than those of headings 744.14 and 744.15)
723 Civil engineering and contractors' plant and equipment; parts thereof
724 Textile and leather machinery, and parts thereof, n.e.s.
725 Paper mill and pulp mill machinery, paper-cutting machines and other machinery for the manufacture of
paper articles; parts thereof
726 Printing and bookbinding machinery, and parts thereof
727 Food-processing machines (excluding domestic); parts thereof
728 Other machinery and equipment specialized for particular industries; parts thereof, n.e.s.
73 Metalworking machinery
731 Machine tools working by removing metal or other material
733 Machine tools for working metal, sintered metal carbides or cermets, without removing material
735 Parts, n.e.s., and accessories suitable for use solely or principally with the machines falling within groups 731
and 733 (including work or tool holders, self-opening die-heads, dividing heads and other special attachments
for machine tools); tool holder
737 Metalworking machinery (other than machine tools), and parts thereof, n.e.s.
74 General industrial machinery and equipment, n.e.s., and machine parts, n.e.s.
741 Heating and cooling equipment, and parts thereof, n.e.s.
742 Pumps for liquids, whether or not fitted with a measuring device; liquid elevators; parts for such pumps and
liquid elevators
743 Pumps (other than pumps for liquids), air or other gas compressors and fans; ventilating or recycling hoods
incorporating a fan, whether or not fitted with filters; centrifuges; filtering or purifying apparatus; parts thereof
744 Mechanical handling equipment, and parts thereof, n.e.s.
745 Non-electrical machinery, tools and mechanical apparatus, and parts thereof, n.e.s.
746 Ball- or roller bearings
747 Taps, cocks, valves and similar appliances for pipes, boiler shells, tanks, vats or the like, including pressurereducing
valves and thermostatically controlled valves
748 Transmission shafts (including camshafts and crankshafts) and cranks; bearing housings and plain shaft
bearings; gears and gearing; ball screws; gearboxes and other speed changers (including torque converters);
flywheels and pulleys (including pulley bloc)
749 Non-electric parts and accessories of machinery, n.e.s.
77 Electrical machinery, apparatus and appliances, n.e.s., and electrical parts thereof (including non-electrical
counterparts, n.e.s., of electrical household-type equipment)
771 Electric power machinery (other than rotating electric plant of group 716), and parts thereof
772 Electrical apparatus for switching or protecting electrical circuits or for making connections to or in electrical

circuits (e.g., switches, relays, fuses, lightning arresters, voltage limiters, surge suppressors, plugs and
sockets, lamp-holders and junct
773 Equipment for distributing electricity, n.e.s.
774 Electrodiagnostic apparatus for medical, surgical, dental or veterinary purposes, and radiological apparatus
775 Household-type electrical and non-electrical equipment, n.e.s.
778 Electrical machinery and apparatus, n.e.s. (at the exception of "778 Electrical machinery and apparatus, n.e.s.")

B. WTO Classification of the Machinery Sector under the Harmonised System

Non-electrical machinery: HS-6 categories 7321-22, Ch. 84 (except 846721-29), 8608, and 8709.

Electrical machinery: HS-6 categories 846721-29, and Ch. 85 (except 8519-24).

C. NACE Classification of the Machinery Sector

USED FOR EU MECHANICAL ENGINEERING SECTOR
NACE Rev.1 2911 - Engines and turbines, ex. aircraft, vehicle and cycle mach.
NACE Rev.1 2912 - Pumps and compressors
NACE Rev.1 2913 - Tapes and valves
NACE Rev.1 2914 - Bearings, gears, gearing and driving elements
NACE Rev.1 2921 - Industrial furnaces and furnace burners
NACE Rev.1 2922 - Lifting and handling equipment
NACE Rev.1 2923 - Non-domestic cooling and ventilation equipment
NACE Rev.1 2931 - Agricultural tractors
NACE Rev.1 2932 - Other agricultural machinery
NACE Rev.1 2940 - Machine tools, woodworking machinery, welding equipment
NACE Rev.1 2951 - Machinery for metallurgy
NACE Rev.1 2952 - Machinery for mining and quarrying and construction
NACE Rev.1 2953 - Machinery for food, beverage and tobacco processing
NACE Rev.1 2954 - Machinery for textile, apparel and leather production
NACE Rev.1 2955 - Machinery for paper and paperboard production
USED FOR EU ELECTRICAL MACHINERY SECTOR: NACE REV. 1 AND 2971
NACE Rev.1 29.71 - Electric domestic appliances
NACE Rev.1 31.10 - Electric motors, generators and transformers
NACE Rev.1 31.20 - Electrical distribution and control apparatus
NACE Rev.1 31.30 - Insulated wire and cable
NACE Rev.1 31.40 - Accumulators, primary cells and primary batteries
NACE Rev.1 31.50 - Lighting equipment and electric lamps
NACE Rev.1 31.61 - Electrical equipment for engines and vehicles
NACE Rev.1 31.62 - Other electrical equipment n.e.c.