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Key Social Impacts of Electronics Production and WEEE-Recycling in China

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1 Background

China plays a key role in the electronics industry and produces a significant share of the worldwide output. In 2006, 72 million notebook PCs and 229 million desktop PCs were sold worldwide. China produces 77% of the global output of notebook PCs and 21% of desktop PCs respectively (NBSC, 2006). In 2005, global shipments of CRT televisions were 158 million (Display, 2007) whereas China has produced 79 million units or 50% (NBSC, 2005). Additionally, a large amount of Chinas exports from the electronics industry are components and semi-finished products for final assembling in regional markets, in particular for desktop PCs.

The electronics industry is a major economic driver in China. Manufacturing of information and communication equipment make up 10.2% of the countries industrial output value and 6.3% of the industrial profits (NBSC, 2006). In 2005, the Chinese electronics industry generated a trade surplus of 65.5 billion US$ or 64.2% of the country's total surplus (WTO, 2006). The export share of notebook PCs and LCD monitors is 94% and 88% respectively, for LCD TVs, mobile phones and CRT monitors an export share higher than 70% is observed.

Undeniably, the electronics industry is highly relevant for the Chinese economy and seems to continue being important in the future. Nevertheless there are an ongoing discussions on the social and environmental sustainability of this sector in China and worldwide. These discussions mainly address labour issues, health and safety and environmental pollution in production, product use and end-of-life treatment. This study shall contribute to objectify the discussion on social sustainability of the Chinese electronics industry by systematically analysing positive and negative social impacts during electronics production and end-of-life treatment in China. Thereby the study shall provide a basis to identify intervention strategies for increasing the overall social performance of electronic products.

This study is part of the Sino-Swiss cooperation project "Sustainable Development: China and Global Markets". The project aims to identify and assess China's role and potential in driving sustainable management with respect to three major industrial sectors, namely cotton & textile, timber and e-products. Furthermore, it aims to identify where the sustainability impacts of the respective product chains are most important and which economic actors are best placed to "drive" change towards full cost internalization of product chain activity.

Based on the results of the sectoral product chains studies, recommendations are made and put forward to the Minister of the Chinese Ministry of Commerce (MOFCOM) on possible policy initiatives for China itself or China acting together with its trading partners to address sustainable development challenges facing them.

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2 Methodology

This chapter analysis the social impacts of electronics production and WEEE-recycling in the People's Republic of China. The research builds on the methodology of Social Life Cycle Assessment (SLCA), which was adapted to the needs of commodity chain analysis. Although there is no internationally standardised SLCA-method yet, the approach is closely aligned to the principles developed by the UNEP Task Force *Integration of social aspects into LCA*, which acts as a steering body for related approaches (UNEP, 2006). A detailed description of the methodology is laid out in *PROSA – Product Sustainabiliy Assessment* (Grießhammer et al; 2007).

Section of commodity chain and system boundaries

The analysis of electronics manufacturing covers component manufacturing, component assembly and final equipment assembly. Supplier industries that are not grouped under *electronics manufacturing* (e.g. raw material extraction and processing, chemical industry, manufacturing of machinery and production equipment) are excluded from the research. The analysis of WEEE-recycling covers collection, disassembly and material recovery.

In general the study only covers social impacts within the People's Republic of China excluding Hong Kong, Macao and Taiwan. An exception is made for the topic *Impacts on conflicts* (section 3.3.6), which cannot be treated sufficiently without taking international relations into account.

Indicators used

The analysis uses the PROSA-set of social indicators, which are grouped into the four major stakeholder-groups *Employees*[1], *Local Communities*, *Society*[2] and *Users*[3]. The used combination of indicators does in some cases result in overlaps with environmental and

[1] In order not to complicate the analysis, the research focuses on employees that are particularly vulnerable to violations of social minimum standards (low-skilled workers).

[2] For this application, society is defined as the whole Chinese population.

[3] Since commodity use is excluded from the research, the impacts on users are not analysed here.

economic aspects. In order to provide a comprehensive picture of related social issues, these overlaps are unavoidable and should not be misinterpreted as “double-counting” of certain issues. Due to severe data shortages, the PROSA-indicators *Community engagement*, *Public commitment to sustainability issues*, *Vocational training, Social and environmental minimum standards for suppliers* and *Transparent business information* were not applied for the research on electronics production and WEEE-recycling. In order to cover these topics, more detailed studies and field visits would be necessary.

Date sources and quality requirements

The analysis uses a combination of qualitative and quantitative indicator values. Data are mainly collected from existing studies and statistics, but – for the case of electronics production – were also gathered during own field visits carried out in April 2006 in relation with the study *Social impacts of the production of notebook PCs* (Manhart & Grießhammer, 2006). For WEEE-recycling an additional group-interview was carried out with Rolf Widmer, Martin Eugster and Martin Streicher – three WEEE-experts at EMPA (Swiss Federal Laboratories for Materials Testing and Research). Generally data availability is still limited for both topics due to the delicate nature of the issue: Besides positive aspects, both industries do feature negative social impacts, which are frequently tried to be hidden from systematic research by various actors. Therefore the analysis has in many cases to refer to anecdotic evidence instead of systematic quantitative indicators.

In order to achieve maximum objectivity, disputed topics are treated with care, relying on a broad variety of reputable sources. Nevertheless data limitations do in some cases hamper this approach. Where this is the case, limitations are laid out in the text.

Due to differences in statistical data classification, the boundary to manufacturing of electric equipment is blurred and might result in allocation uncertainties. In those cases where these uncertainties might influence the research results, this is mentioned in the text.

Since social aspects can change quickly, the data used is – except from some few exemptions – not older than four years.

3 Electronics production

In the last decade China managed to establish as one of the world's most important production base of electronics. While the country is undisputed world leader of labour intensive product assembly, China also managed to upgrade the industry and to attract a significant share of high-end production technologies like the fabrication of chips and electronic parts.

In recent years, electronics companies were increasingly blamed for labour rights abuses and the violation of basic health standards within their Chinese production bases.

3.1 Impacts on employees

3.1.1 Safe and healthy working conditions

The main health problems reported in the electronics industry worldwide arise primarily from the handling of toxic materials and the prolonged exposure to vapours. Most incidents reported are linked to the semiconductor industry, where several surveys yielded increased rates of cancer as well as elevated rates of spontaneous abortion among female workers (LaDou, 2006). Although there are no studies on the Chinese semiconductor industry available yet, it seems very plausible that its employees are exposed to similar risks. This is partly due to the fact, that about 20% of the semiconductor industry in China applies used equipment imported from OECD-countries and therefore cannot benefit from the latest health and safety standards (PwC, 2004 & 2007; LaDou, 2006). Furthermore Pricewaterhouse Coopers (2004) raised the concern that domestically owned semiconductor companies in China will likely spend less to protect workers' health in order to compensate the cost advantages of international operating firms that – due to the latest technologies – can produce more efficiently.

Besides the semiconductor industry there is strong evidence, that similar problems do arise in less prominent production processes like the manufacturing of printed circuit boards, batteries, plastic parts, cases and cables in China (CAFOD, 2003; Schipper & de Haan, 2005; Frost, 2006a; SACOM, 2006). Although it is difficult to match the use of certain substances with diseases that might develop years after exposure, some cases of lead- and cadmium-poisoning seem quite obvious (Leong & Pandita, 2006; Frost, 2006a). As a reaction to the risks certain substances pose to health and environment, the European RoHS-directive and the Chinese regulation on "Management Methods on Control of Pollution from Electronic Information Products" (China RoHS) widely ban cadmium, lead, mercury, hexavalent chromium and the flame retardants PBB and PBDE from electronic products. Although there is no information on the regulations' impacts yet, it can be presumed that strong enforcement will reduce some of the health risks in the industry.

Besides chemicals, there are several other health and safety risks reported for electronic fabrics in China. These include injuries from machinery handling, factory fires, ergonomic detractions from monotonous line-work and eye strain caused by the handling of small parts and visual quality inspections (CAFOD, 2003; Schipper & de Haan, 2005; Leong & Pandita, 2006; Xinhua News Agency, 2007). Generally it is not clear whether these types of risks are significantly higher or lower than in other manufacturing industries in China. In terms of identifying enterprises most at risk, some experts argue that small and medium-sized companies are generally more vulnerable to the violation of health and safety standards than big entities (Liu, 2005).

3.1.2 Freedom of association and right to collective bargaining

Although the ILO core labour standards No. 87 *Freedom of Association and Protection of the Right to Organise Convention* and No. 98 *Right to Organise and Collective Bargaining Convention* have not been ratified by the People's Republic of China yet, the Chinese Labour Law does allow affiliates of the All China Federation of Trade Unions (ACFTU) in companies with 25 employees or more. Nevertheless it is reported that in most electronic enterprises unions are widely absent (Schipper & de Haan, 2005). In some cases it is even reported, that attempts to set up ACFTU-affiliates were prevented by dismissing employee spokespeople (China Labour Bulletin, 2005). According to several reports, many workers either do not have the possibility to complain to the management or filed grievances are widely ignored (CAFOD, 2003; SACOM, 2006).

Due to the official efforts to promote a “harmonious society”, the proportion of worker representations in foreign companies is planned to be increased drastically (Chan, 2006; Maass, 2006). Since a big proportion of electronics industry in China runs with foreign capital[4], this is likely to affect the industry in the near future. A start was made in December 2006, when a grassroot ACFTU-affiliate was founded in a major *Foxconn*-factory near Shenzhen (China Post, 2007)[5]. Nevertheless the possible impacts of union-affiliates on labour conditions widely correlate with their willingness and ability to operate in favour of their members. With regards to cases were ACFTU-affiliates were closely interlinked with the management (UBS, 2005; Chan, 2006), it is likely that those impacts will be limited in many cases.

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[4] While 17% of the electronics manufacturing enterprises in China run with foreign capital, these companies generate 99.5% of the output value in this segment (NBSC, 2006).

[5] *Foxconn* is the world’s biggest electronic manufacturing service enterprise (EMS) with more than 200,000 employees and numerous production sites in China. Therefore the case is of considerable importance for the industry.

3.1.3 Equality of opportunity and treatment and fair interaction

Almost all reports on electronic equipment manufacturing mention a predominance of young female employees in low-skilled activities, a claim that is also supported by numerous pictures on company websites. Although there is little direct evidence that older workers are discriminated against during recruitment and contract-renewal, the obvious absence of this group can hardly be explained otherwise.

3.1.4 Forced labour

There are no reports on cases of forced labour in the electronics industry in China.

3.1.5 Child labour

In is widely agreed that child labour has not been a major issue in the Chinese electronics industry so far (Manhart & Grießhammer, 2006). Nevertheless there is one recent report on more than 200 under-aged students working in an electronic assembly firm in so called "summer jobs" (SACOM, 2006). This report adds to the concerns of some analysts about a general increase of child labour in the Chinese manufacturing bases due to labour shortages (Cheung & Welford, 2005; Frost, 2006b; China Labour Bulletin, 2006).

3.1.6 Remuneration

Electronic equipment manufacturing holds many low-skilled jobs, were remuneration is generally based on the regional minimum wages, which is currently 690 RMB for major production regions (Guangdong, Shanghai, Jiangsu) with maximum levels of 780 RMB in the city of Guangzhou and 810 RMB in Shenzhen. Nevertheless there are reports on systematic violations of these thresholds in some production sites (CAFOD, 2003; Schipper & de Haan, 2005; SACOM, 2006; Leong & Pandita, 2006): While in some cases workers can only achieve the minimum wages doing overtime, other companies deduct a substantial portion of the salary for housing and catering. Furthermore there are cases where overtime is not compensated at a premium rate and where employees are made financially liable for quality-losses or misconduct. According to SACOM (2006) these deductions can sum up to more than 50% of the basic salary. Nevertheless the sector offers also numerous jobs for higher educated workforce. Therefore the average wages in manufacturing of ICT-products lay significantly (28.8%) beyond those in the total manufacturing industry[6] (NBSC, 2006).

[6] While the average wages in „Manufacturing of Communication Equipment, Computer and other Electronic Equipment“ are at 20,299 RMB per year, the figure is 15,757 RMB for all manufacturing industries.

3.1.7 Working hours

Electronic equipment assembly in China is usually organised in two daily shifts of 8 hours. During peak seasons, each shift can be extended to 11 hours, so that – except from some breaks – production can be maintained almost round the clock (Manhart & Grießhammer, 2006). If workers are not relieved by colleagues and continue to work on weekends, this practice might lead to 330 monthly working hours, 120 more than the legal maximum. In fact several surveys did document such excessive working hours (Schipper & de Haan, 2005; Torres, 2005; Wilde & de Haan, 2006; SACOM, 2006). Nevertheless there is also evidence that this is not the case for all factories (SACOM, 2006).

3.1.8 Employment security

Since 2003 the electronics industry in China has experienced a steady growth of jobs (ILO, 2007; see section 0) with no mass layoffs. Nevertheless few employees hold long term contracts (SACOM, 2006) and especially elderly assembly-line workers may face non-renewal of labour contracts (see section 3.1.3). Regarding the electronics industry crises at the beginning of the decade with reductions of jobs worldwide (ILO, 2007), a similar situation in the future might endanger employment security in China.

3.1.9 Social security

Chinese labour law specifies that workers should enjoy basic social security covering the areas of health, unemployment and old age pensions. While some electronics production facilities do fulfil these obligations, others do not provide any insurance schemes for low skilled workers (SACOM, 2006).

3.1.10 Professional development

The majority of activities in the Chinese electronics manufacturing industry do not require any special experience or initial training. Assembly line workers generally receive a several-day introduction when they commence employment and are then assigned directly to the corresponding position on the assembly line (Manhart & Grießhammer, 2006). In at least one multinational company employees do have the possibility to join computer and vocational training courses free of charge (SACOM, 2006).

3.1.11 Job satisfaction

Although there is no survey on job satisfaction in the Chinese electronics industry yet, a recent study revealed an average monthly turnover rate of 8% in electronics manufacturing enterprises in Shenzhen, reflecting a high level of dissatisfaction with working conditions[7]. Small enterprises with less than 500 workers feature turnover rates as high as 20% per month. Enterprises with more than 15.000 employees reported monthly turnover rates of 6% (FIAS, 2007).

3.2 Impacts on local communities

3.2.1 Safe and healthy living

The health impacts of the Chinese electronics industry on neighbouring communities have not been studied in detail yet. What is known is that some segments of the electronics industry – above all, semiconductor manufacturing – cause a disproportionate level of pollution, relative to the economic value they generate (Williams et al; 2002). Similarly, the production of other electronic components is associated with substantial air and water pollution as well as problematic waste materials. According to the results of an LCA for desktop PCs, the emissions of copper, selenium, mercury, fluoranthene and nickel in the production of electronic parts are the most problematic. The production of printed circuit board material also results in oil emissions. In the manufacturing of PVC parts, wastewater is polluted with cadmium. The assembly of electronic devices, on the other hand, is largely free of toxic emissions (Choi et al; 2006). These assumptions are supported by analytic measures on soil and wastewater samples collected around production facilities in China (Bridgen et al; 2007): The wastewater of two printed circuit board manufacturing sites carried contaminations of bromated flame retardants, one phosphorus based flame retardant, benzophenone, dephenylethanone, a thioxanthen-9-one derivative, phthalate esters, alkyl benzenes, aliphatic hydrocarbons, sterols derivatives and high concentrations of copper, nickel, lead, tin and zinc. Furthermore high copper and tin concentrations as well as several flame retardants were found in soil samples near the sewers. Since a large portion of industrial sites in China are situated between agricultural lands, it is likely that some of these contaminants do enter the human food chain.

3.2.2 Human rights

There are no reports on the violation of human rights in the neighbourhood of electronics production sites that were linked to the industry's activities. Nevertheless there are a number of reports on the rededication of land and the forced resettlement of the resident population

7 High turnover rates are also influenced by the general conditions of the job market. In Shenzhen region, a current shortage of cheap labour increases the employment opportunities for low skilled workers, partly resulting into high fluctuation.

for the purposes of industrialisation, which in some cases led to violence (Frost, 2006c). It is not known if the electronics industry is actively involved in such disputes.

3.2.3 Indigenous rights

There are no reports on the violation of indigenous rights associated with the electronics industry in China.

3.2.4 Social and economic opportunities

The large number of new industrial estates – including electronics manufacturing facilities - on the east coast of the People's Republic of China has led to substantial economic growth and rapidly rising per-capita income in the locality. In the course of a rapid technological learning process, this economic growth has also been a springboard for the creation of high quality jobs. The great demand for low-qualified workers opens up employment opportunities primarily for migrant workers from other parts of the country[8]. Whilst the quality of these jobs is doubtful in many cases (see section 3.1), these employment opportunities offer alternatives to agricultural work or the widespread rural unemployment. Ping & Shaohua (2005) assert that money transfers from migrant workers to their home regions also spread positive social and economic benefits to those regions[9]. Moreover, many migrant workers return home with savings which enable them to found their own small businesses and achieve a not inconsiderable level of social advancement.

These positive economic and social impacts at local level are often offset by negative effects, however: besides the risks to health and safety (see section 3.2.1) and the resettlement of local communities (see section 3.2.2) the establishment of industrial plants generally competes for environmental resources with environmentally-dependent sectors, particularly agriculture and fishery. Employees in these sectors might therefore suffer a decline in social and economic opportunities.

[8] In Guangdong province – a major centre of the Chinese electronics industry – migrant workers account for 65% of the labour force in manufacturing (Hess, 2007).

[9] According to Ping & Shaohua (2005), cash transfers from migrant workers to their regions of origin are primarily used to meet regular housekeeping expenses, for children's education, house building and improving agricultural production.

3.3 Impacts on society

3.3.1 Unjustifiable risks

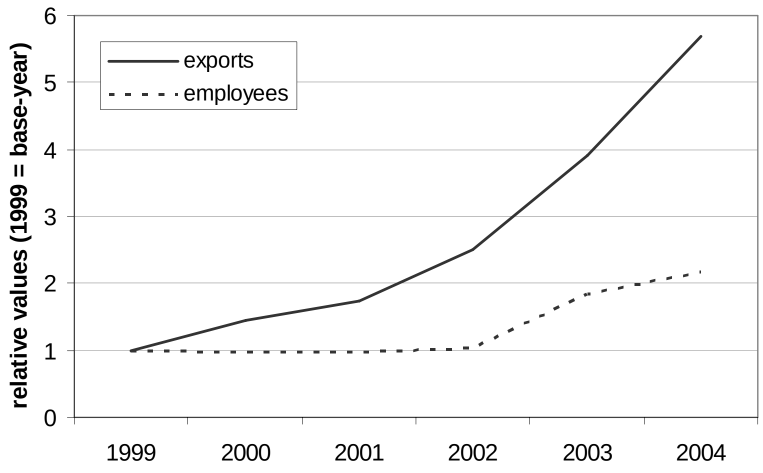
The electronics industry, and particularly the manufacturing of electronic household appliances, is not under suspicion of directly generating unjustifiable risks for the rest of society. Nevertheless one could argue that severe pollution generated by some parts of the electronics industry (see section 3.2.1) is a significant long term risk that cannot be justified by economic development.

Furthermore the flows of Chinese migrant workers – which are amongst others attracted by job opportunities in the electronics industry – are shown to have a causal relationship with the spread of HIV/AIDS in China (Winkelmann, 2004; Frost, 2005). The extent to which actors in the electronics industry are contributing to solving this problem is largely unknown.

3.3.2 Employment creation

Since 2003 the electronics industry in China led to a constant increase in the number of jobs. Depending on the data source, between 2.27 and 6.3 million people are employed in the electronics industry in China (NBSC, 2006; ILO, 2007)[10]. In any case, the electronics industry is currently amongst the three most important Chinese manufacturing industries from an employment creation perspective[11] (NBSC, 2006). Nevertheless the growth of jobs is significantly lower than the total electronics industry growth rate. While electronics exports grew at a factor of 5.7 between 1999 and 2004, according to ILO-data the number of employees grew at a factor of 2.2 (see figure 1). This is mainly due to increasing mechanisation, which is not only driven by technological innovation, but also by the ongoing product miniaturisation. PCB-mounting is a prominent example thereof: While electronic boards and cards were mounted manually only a few years ago, the increasing integration density in most product groups can only be achieved using automatic assembly machines. This trend of increasing mechanisation is very likely to continue for the next years, which bears considerable risks for employment creation: Slower future growth rates will likely level off employment creation as this was already the case between 1999 and 2002 (figure

Figure 1: Exports and employment in the Chinese electronics industry



Source: WTO, 2004-2006; ILO, 2007

[10] The differences can partly be explained by the fact that the National Bureau of Statistics uses the definition „manufacturing of communication equipment, computers and other electronic equipments“, while the ILO also includes employees in electrical product manufacturing. Nevertheless inconsistencies within the China Statistical Yearbook (two diverging figures: 2.269 million (p. 135) and 4.3548 million (p.507) cannot be explained likewise.

[11] Manufacturing of textiles: 2,716,000; Manufacturing of transport equipment: 2,295,000 jobs; Manufacturing of communication equipment, computers and other electronic equipment: 2,269,000 jobs.

1). Industry crises with only little growth rates might as well lead to significant reductions of jobs.

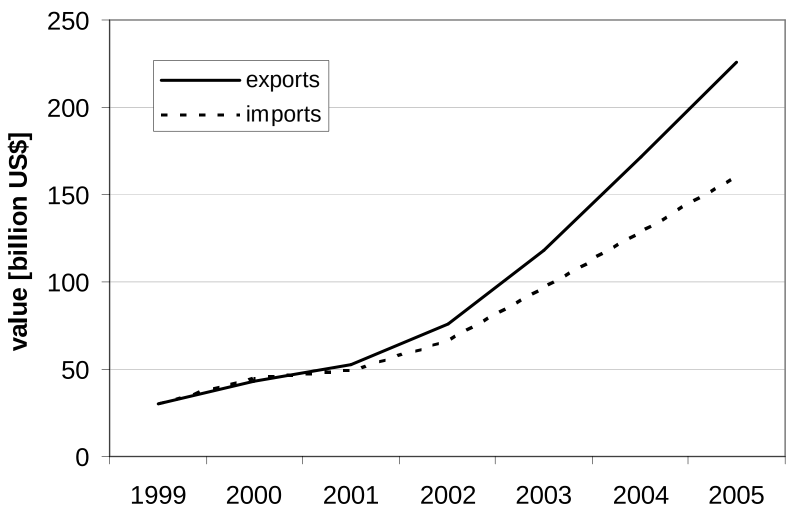
3.3.3 Corruption

Apart from some anecdotic style information, there is no comprehensive survey on corruption in the electronics industry in China. In a worldwide sector ranking by Transparency International, the electronics industry (as part of *light manufacturing*) ranks amongst those industries that are not particularly prone to corruption (TI, 2002).

3.3.4 Contribution to the national economy

The electronics industry is a major economic driver in China. "Manufacture of communication equipment, computers and other electronic equipment" make up 10.2% of the countries industrial output value and 6.3% of the industrial profits (NBSC, 2006). It is a major source of foreign direct investments and increasingly contributes to the positive foreign trade balance. While China used to import about as much electronics as it could export until 2001, the country managed to upgrade the industry and gain an increasing share of the total value added (see figure 2). In 2005, the Chinese electronics industry generated a trade surplus of 65.5 billion US$ or 64.2% of the country's total surplus (WTO, 2006). These figures mainly go back to component and product manufacturing. Electronic parts and integrated circuits are also produced in China but the industry still heavily relies on imports (WTO, 2006; PwC, 2007).

Figure 2: Export and import-values of office and telecom equipment [A]



[A] Includes electronic data processing devices, integrated circuits and electronic components.

Source: WTO, 2002-2006

According to some analysts, the electronics industry will remain the major source of China's export revenues in the near future (SZ, 2007).

3.3.5 Contribution to the national budget

The electronics industry is highly subsidised in China. In order to attract investments, combinations of land subsidies, loan subsidies, discounts on utilities and logistical support, and preferential tax treatments are routinely granted by the national and provincial administrations (PwC, 2004; AA, 2005). For this reason the tax revenues from the electronics industry are much lower than from other Chinese industries (see table 1).

Table 1: Taxes and industry profits in 2004.

	Total profits [100 million RMB]	Taxes and other charges [100 million RMB]	Taxes in percentage of the total industry profits
Manufacture of communication equipment, computers and other electronic equipment	823.86	25.96	3,2%
Manufacture of textile wearing apparel, footware and caps	173.15	25.50	15,3%
Manufacture of plastics	218.99	35.16	16,1%
Manufacture of textiles	317.82	62.00	19,5%
Recycling and disposal of waste	98.38	16.39	20,6%
Manufacture of transport equipment	813.19	217.39	26,7%

Source: NBSC, 2006

While the industry paid 2.596 billion RMB (340 million US$) to the Chinese government in 2004, an adjustment of taxation policies to those of other sectors would yield additional fiscal revenues of 9.862 to 13.881 billion RMB (1.280 to 1.820 billion US$) annually[12].

In the case of chip fabrication - a major priority in the current 5-year plan - subsidies by provincial and municipal governments for new plants could contribute to excess capacity worldwide, which would in turn threaten the economic stability of this sector (PwC, 2007).

3.3.6 Impacts on conflicts

The growing interdependencies among major economies led to a de fact calming of conflicts in recent years. This is especially the case for the relations between the People’s Republic of China and the Republic of China (Taiwan): Since the bulk of PR China’s electronics exports

12 Assuming tax rates of 15% and 20% of the total industry profits.

are actually made by Taiwanese-run factories[13], an escalation of the dispute would significantly impact both economies (Yang, 2006). Therefore the current structure of the electronics industry reduces the probability of conflict escalation.

On the other hand, heightened demand for raw materials used in electronic products gives rise to conflicts over resources: In 2001 the global electronics industry was accused of indirectly financing the war in the Democratic Republic of Congo, due to the sector's high demand for tantalum[14] (Hayes & Burge, 2003). Whilst the market for the metal stabilised after 2001, the general problem has persisted: various metals used in electronic components are supplied from regions which are rife with political instability. Some of these raw materials – including tantalum and to a lesser extent palladium – are used primarily in the electronics industry, so that social, political and environmental impacts of the related supply chains can be attributed more or less directly to the industry. Since China holds an increasing share of the global electronics production, it is likely that the Chinese electronics industry will sooner or later be linked to such conflicts.

Some experts diagnose increasing social polarisation with risks to political stability in China (Alpermann, 2004; Messner & Humphrey, 2006). In 2005 there were 87,000 social conflicts and protests, which is an increase of 18% in comparison with the year 2004, and 50% compared with 2003 (Willmann, 2006). The primary causes of these protests are said to be the expropriation of agricultural land for industrial use, the pollution of agricultural resources, and conflicts between company managers and migrant workers (Cody, 2005). All these causal factors are closely related to China's economic development. The degree to which influences from the electronics industry are playing a part as triggers of conflict are not known. Nevertheless it seems likely that some of the impacts described in section 3.1 and 3.2 do contribute to social tension.

3.3.7 Intellectual property rights

For multinational companies the topic of intellectual property rights gets an increasingly high priority in relation with investments in China. Many actors fear that innovative technologies are not safe from patent infringement in China and therefore refrain from investing into high-tech and up-to-date production sites (PwC, 2004; Maskus et al; 2005; Pecht, 2007). From a social and environmental point of view, this has serious repercussions for China's electronics industry: On the one side it will get harder for Chinese actors to catch up with up-to-date

[13] Although only 17% of the electronics manufacturing enterprises in China run with foreign capital (including capital from Taiwan, Hong Kong and Macao), these companies generate 99.5% of the output value in this segment (NBSC, 2006).

[14] The precious metal tantalum is supplied in the form of the columbite-tantalite ore – better known by the contracted form of its name, "coltan".

technologies in high-tech segments like chip-fabrication, on the other side the country will continue to receive investments in older production technologies that – for the health and safety reasons – are often not acceptable in other countries any more (PwC, 2004).

4 WEEE-Recycling

The Chinese WEEE-recycling industry is one of the biggest of its kind worldwide: While the industry is not only treating 1.76 million tons of annually produced domestic e-waste, but also large amounts of imported WEEE that cannot be quantified due to the illegal status of the shipments. In recent years, the industry increasingly became subject to broad public attention caused by severe impacts on human and environmental health.

4.1 Impacts on employees

4.1.1 Safe and healthy working conditions

The Chinese WEEE-recycling industry is widely associated with severe health and safety risks for workers involved in this sector (Pucket & Smith, 2002; Brigden et al; 2005; Terazono et al; 2006). These risks mainly stem from improper techniques during the recovery of raw materials like the open burning of wires and the chemical treatment of PCBs and electronic parts. Especially in the informal structures of the Chinese WEEE-recycling industry only very few basic precautionary measures are applied to protect workers' health. As a result, occupational effects have already been reported and include diseases of the skin, stomach, respiratory tract and other organs (Hicks et al; 2005; Terazono et al; 2006). Widmer et al. (2007) point out, that about 20% of the employees are exposed to such extreme health-threatening working environments: While workers engaged in WEEE-collection do face negligible health risks from the waste itself, people in the manual disassembly of WEEE can widely avoid major health risks using low-tech precaution measures like basic inhalation protection against dust. This view is supported by a study on WEEE-collection and disassembly structures in Beijing, which found out that these processes (as practiced in Beijing) do not expose workers to major health risks (Eugster & Fu, 2004). Nevertheless many actors in the Chinese WEEE-recycling industry are either not aware of existing health risks or have only limited knowledge on basic protection measures (Widmer et al; 2005) and may therefore be exposed to risks that would be easy to mitigate.

4.1.2 Freedom of association and right to collective bargaining

Apart from some very few exemptions, the Chinese WEEE-recycling-industry is organised in small, informal enterprises (Tong & Wang, 2004; Xianbing & Masaru, 2006; Jinhui et al; 2006; Widmer et al; 2007), which typically do not feature formalized workers' participation mechanisms.

4.1.3 Equality of opportunity and treatment and fair interaction

Due to the widespread informality of the sector, there are no comprehensive figures on the composition of workforce. Similarly there is little information on hierarchies or disciplinary practices. One consistent feature is the division of workforce into local business-people and migrant workers who typically carry out labour intensive tasks and are described as the most vulnerable group in the WEEE-recycling industry (Sun Yat-sen University & Greenpeace, 2003). Nevertheless a large portion of the industry consists of small-scale family based enterprises (Tong & Wang, 2004) or two man-operating collection entities (Eugster & Fu, 2004) giving rise to the assumption that discrimination does not occur systematically.

4.1.4 Forced labour

There are no reports on forced labour within the Chinese WEEE-recycling industry.

4.1.5 Child labour

The report "exporting harm", which first brought up the e-waste topic internationally, featured one picture with children sorting plastic from WEEE-recycling in *Guiyu* (Puckett & Smith, 2002). In the following publications on recycling techniques and waste streams, the topic of child labour was not addressed. Therefore the extent to which child labour is used in the industry is widely unknown.

4.1.6 Remuneration

According to official figures, employees in "Recycling and Disposal of Waste" have an average yearly income of 15,349 RMB, which is below the national salary of staff and workers (18,364 RMB) (NBSC, 2006). Nevertheless this figure only accounts for licensed enterprises, which make up only a small share of the total recycling industry. The absolute value is therefore not representative for the whole WEEE-recycling industry.

An anthropological survey on the WEEE-recycling industry in *Guiyu* revealed an average worker's salary of less than 30 RMB (3.63 USD) per day (Sun Yat-sen University & Greenpeace, 2003). This figure is supported by a study on informal WEEE-disassembly enterprises in Beijing, which yielded daily salaries of 10 to 40 RMB with an average value of 28 RMB (Eugster & Fu, 2004). With a daily salary of 28 RMB and 30 working days per month this would sum up to 10,080 RMB per year, which is significantly lower than the figure for the formal part of the recycling industry.

4.1.7 Working hours

Due to the informal character of the industry, there is little information on working hours: In Beijing, WEEE-disassembly enterprises typically operate 8 hours per day and 30 days per month (Eugster & Fu, 2004), which does result in 240 monthly working hours per employee.

Generally many WEEE-recycling activities are carried out in open courtyards, where operation is bound to daylight hours. Therefore it seems very unlikely that operation exceeds 10 or 11 hours per day. Furthermore WEEE-recycling activities are not organised in strict production lines, so that individual workers may arrange working hours and rest periods to their specific needs. If this setting is actually utilized in favour of the workers, is widely dependent on business culture and the practised interaction between management and employees.

4.1.8 Employment security

Although it can be assumed that only a minority of Chinese WEEE-recycling workers do hold labour contracts, employment perspectives for WEEE-recycling workers are generally positive due to following factors:

- The Chinese WEEE-volume is growing steadily and is predicted to continue doing so (Jinhui et al; 2006)
- The domestic demand for resources is steadily growing and own deposits are scarce (Hicks et al; 2005)
- Labour intensity continues to be high in the informal WEEE-recycling structures (Widmer et al; 2007).

Nevertheless there are recent attempts to formalize the WEEE-recycling system in China which includes the reform of the established collection, disassembly and material recovery systems (Xianbing & Masaru, 2006; Widmer et al; 2007). For the case that this reform leads to a vast replacement of the existing WEEE-recycling structures, employment security will be seriously threatened for many people working in this sector.

4.1.9 Social security

Due to the informality of the sector most employees are not covered by health insurances, unemployment and old age pensions schemes. Nevertheless the widespread family-structures in WEEE-recycling do provide at least basic levels of social security for family members. Generally this does not necessarily hold true for migrant workers, which make up between half and to two thirds of the total workforce in WEEE-collection and recycling (calculated after Eugster & Fu, 2004[15] and Sun Yat-sen University & Greenpeace, 2003[16]).

[15] Beijing: 10,000 employees whereof 5,000 migrant workers

[16] *Guiyu*: 150,000 local population whereof 60~80% (median = 70%) of the families are engaged in the WEEE-recycling industry. Migrant workers in WEEE-recycling: 100,000. Share of economic active population in China: 60%.

Nevertheless some entrepreneur in WEEE-recycling industry claim to cover the medical fees of their employees (Sun Yat-sen University & Greenpeace, 2003).

4.1.10 Professional development

Although a better risks awareness is seen as one key aspect to mitigate negative impacts on health and environment (Widmer et al; 2005), there are currently few efforts to increase the knowledge base of management and workers in the informal WEEE-recycling sector. Although some recyclers claimed to be principally interested in upgrading technology and know-how, widespread negativism associated with WEEE-recycling together with the insecure future of informal WEEE-recycling enterprises[17] play its role retaining investments in such security orientated professional development (Tong & Wang, 2004; Widmer et al; 2007).

4.1.11 Job satisfaction

Although there is no survey on job satisfaction in the Chinese WEEE-recycling industry, it is reported that turnover rates are clearly above-average (Widmer et al; 2007): Especially migrant workers from rural China use the WEEE-recycling industry as first employment opportunity on the country's industrialized east coast and quit once they are offered better job opportunities in other sectors.

4.2 Impacts on local communities

4.2.1 Safe and healthy living

There have been several studies on environmental and health impacts of WEEE-recycling in *Guiyu*, one of the main Chinese WEEE-recycling clusters where a large portion of the recovery of copper, lead and precious metals is carried out. Results of these surveys include very high levels of heavy metals and organic contaminants in samples of dust, soil, river sediment, surface water and ground water (Puckett et al; 2002; Brigden et al; 2005; Huo et al; 2007). Furthermore severe air-pollution from the incineration of waste is reported (Sun Yat-sen University & Greenpeace, 2003). Generally there is strong evidence that environmental pollution does not only affect the health of employees of the WEEE-recycling industry, but also the health of the local population not directly engaged in the sector: A recent study on blood lead levels of children yielded significantly higher values for children

[17] There are attempts to reform the WEEE-recycling industry in China. Nevertheless the kind and extent of the reform is still unclear.

living in *Guiyu* than for children living in a nearby settlement with no WEEE-recycling industry (Huo et al; 2007).

Furthermore the residual waste, which is almost entirely disposed in uncontrolled landfill sites, is another serious health risks for local communities. According to Terazono et al. (2006) WEEE discarded in this manner is a major source of heavy metal contamination of soils and groundwater. Since many recycling and disposal sites are located close to agricultural land, it is likely that some of these contaminants do enter the human food chain. Besides the direct effects on human health and the environment, many of the described pollutants are persistent and therefore also pose risks to future generations.

Eugster & Fu (2004) stress that - in contrast to material recovery and disposal - collection and disassembly of WEEE does not pose significant harms to the environment.

4.2.2 Human rights

There are no reports on the violation of human rights in the neighbourhood of WEEE-recycling sites that were linked to the industry's activities[18].

4.2.3 Indigenous rights

There are no reports on the violation of indigenous rights associated with the WEEE-recycling industry in China.

4.2.4 Social and economic opportunities

The current informal WEEE-recycling system has significant impacts on the economic development of recycling clusters: In the two major WEEE-recycling centres in China (*Luquiao* in Zhejiang Province and *Guiyu* in Guangdong Province) around 70% of the local families are directly or indirectly active in the industry. In total WEEE-recycling holds 13,000 jobs in *Luquiao* and 155,000 in *Guiyu* (Sun Yat-sen University & Greenpeace, 2003; Tong & Wang, 2004; Xin & Jici, 2004). Around 440,000 jobs are provided by the decentralised collection and disassembly processes (see section 4.3.2). Several authors emphasize the high level of entrepreneurship in this sector that led to a large number of new businesses in the field of re-using components and extracting raw materials (Widmer et al; 2005; Hicks et al; 2005). Furthermore some authors state that WEEE-recycling significantly fuels local

[18] Although severe health and safety hazards for workers and neighbouring communities may be regarded as violations of human rights, in this study these topics are covered in section 4.1.1 and 4.2.1.

economic development because it is one major option to meet other sectors' demand for raw materials (Tong & Wang, 2004; Jinhui et al; 2006).

Nevertheless it is undisputed that the widely applied methods to recover precious metals, lead and copper are severely polluting the local environment, which is further aggravated by dumping of residual waste without any precautionary measures. Several studies documented the level of environmental and health impacts of these practices and it seems clear that they are severe drawbacks for local social and economic development: While direct health impacts create high social and economic cost (see section 4.1.1 and 4.2.1), persistent pollutants negatively impact water and soil quality further threatening human health and local agricultural production. According to Sun Yat-sen University & Greenpeace (2003) agriculture is generally on the retreat in and around *Guiyu*[19], leading to increased poverty amongst families that were formerly engaged in farming and got – for various reasons – not involved in the local recycling industry.

4.3 Impacts on society

4.3.1 Unjustifiable risks

The WEEE-recycling industry is not under suspicion of directly generating unjustifiable risks for the whole Chinese society. Nevertheless severe pollution from the current practices in material recovery and disposal (see section 4.2.1 and 4.2.4) is a significant long term risk that cannot be justified by economic development. This is especially the case for the major recycling centres like *Guiyu* that – regarding bromated flame retardants – rank amongst the most polluted areas in the world (Wong, 2007). Taking into account that many bromated flame retardants like OctaBDE and TBBPA are primarily used in electronic equipment, it is obvious that the currently practised WEEE-recycling is one major source of these pollutants in China.

4.3.2 Employment creation

The following section is based on the study "Employment analysis for WEEE recycling and disposal in China", which was carried out by Duan & Eugster (2007) on the bases of available reports, surveys and estimates:

WEEE-recycling comprises four major stages: Collection, disassembly, material recovery and final disposal. While collection (and some disassembly) is carried out in decentralised

[19] While better income possibilities were identified as the main reasons for this development, environmental pollution is seen as the most important co-factor (Sun Yat-sen University & Greenpeace, 2003)

systems following the occurrence of e-waste, the major part of disassembly and recovery of materials is widely centralized in some few WEEE-recycling clusters. The most important of these clusters are *Guiyu* in Guangdong Province and *Luqiao* in Zhejiang Province. The final disposal of residual waste is until now almost entirely carried out in the location of material recovery without any precautionary measures and does therefore not provide a significant number of jobs.

In total there are about 700,000 people working in the Chinese WEEE-recycling industry, whereof the majority (98%) is employed in informal structures (see table 2).

Table 2: Estimated employment creation in the Chinese WEEE-recycling industry

Stages	Employment		
	Formal	Informal	Total
Collection	-	440,000	440,000
Disassembly	400	125,000	125,400
Material recovery	15,000	125,000	140,000
Final disposal	600	-	600
		Sum	700,000

Source: Duan & Eugster, 2007

4.3.3 Corruption

There is very limited information on corruption within the Chinese WEEE-recycling industry. Nevertheless the sector’s widespread informality is likely to generate some forms of unofficial fee-systems, which can be interpreted as corrupt practice. This assumption is supported by interviews carried out in *Guiyu* in 2003, which revealed some anecdotic evidence for related practices (Sun Yat-sen University & Greenpeace, 2003).

4.3.4 Contribution to the national economy

The sector *Recycling and Disposal of Waste* makes up 0,12% of the countries industrial output value and 0,0007% of the industrial profits (NBSC, 2006). Since these figures are based on official data and since the industry is only partly formalised, the figures are likely to be higher in reality. Nevertheless WEEE-recycling has only a limited share of the total recycling and disposal sector[20].

Some authors stress the importance of the Chinese WEEE-recycling as source of raw materials needed for the countries growing manufacturing sector (Tong & Wang, 2004; Jinhui et al; 2006). Nevertheless there is no quantitative information on the role WEEE-recycling materials play in the development of other sectors. The only economic figure relating to WEEE-recycling is the value creation by the WEEE-recycling cluster of *Guiyu*, which was estimated to be 72 million US$ annually (Dayoo Daily News, cited after Hicks et al; 2005). A calculation of the value creation on the bases of average salaries and the number of workers (see sections 4.1.6 and 4.3.2) yields an annual value of 925 million US$ for the total Chinese WEEE-recycling industry.

Although the majority of the WEEE-recycling industry is still in the hands of local based enterprises, some internationally operating companies have already shown interest in investments in this sector in China (Hicks et al; 2005; Widmer at al; 2007). WEEE-recycling might therefore turn into a source of foreign direct investments in the future.

4.3.5 Contribution to the national budget

Due to the sector's widespread informality and the dominance of small-scale enterprises, many businesses in WEEE-recycling are not included in the national taxation system. Nevertheless formally operating enterprises are – as part of the total recycling and disposal sector – subject to taxation (Sun Yat-sen University & Greenpeace, 2003; NBSC, 2006; see section 3.3.5). According to Yoshida (2005) the recycling industry in *Guiyu* significantly contributes to local tax revenues.

4.3.6 Impacts on conflicts

As laid out in section 3.3.6, heightened demand for raw materials used in electronic products gives rise to conflicts over resources worldwide. The WEEE-recycling industry does subsequently play an important role in reducing these conflict risks: The higher the recovery rate of waste materials and particular materials in discarded electronic products, the lower the pressure on the relating resource deposits like tantalum, gold and palladium. Nevertheless Widmer et al. (2007) point out, that the current material recovery methods in China still offer great untapped potentials.

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20 While the total amount of domestic solid waste in China was 136.5 million tonnes in 2002 (Qifai et al; 2006), the domestic WEEE was 1.76 million tonnes in 2003 (Xianbing & Masaru, 2006). Therefore WEEE makes up roughly 1.3% of the total Chinese domestic waste production.

As already mentioned in section 3.3.6 the pollution of agricultural resources is one reason for an increasing number of social conflicts and protests in China. Although it is unclear whether pollution from the WEEE-recycling industry already spurred protest and violence in the past, severe pollution from WEEE-recycling clusters and its impacts on local living conditions (see sections 4.2.1 and 4.2.4) are an integral part of the link between economic development and the degradation of natural resources.

4.3.7 Intellectual property rights

There is no specific information on the interrelations between intellectual property rights (IPR) and sustainability issues relating to the WEEE-recycling industry in China. Nevertheless it can be assumed that IPR is relevant in terms of product information needed for efficient and sound recycling systems (e.g. information on content-materials and proper treatment). Currently there is no specific information on this issue in China.

5 Summary

Both, electronics production and WEEE-recycling have major social impacts on workers, neighbouring communities and the Chinese society: While electronics production is a major driver for the country's economic development and makes up almost two thirds of the country's export surplus, the economic output of the WEEE-recycling industry is of lesser national importance. Nevertheless WEEE-recycling spurred significant economic developments within the industry's major clusters. In addition, WEEE-recycling is a source of raw materials and has therefore positive economic impacts on other sectors that have not been quantified so far.

In terms of taxes paid, both sectors are clearly below average in relative terms: While many businesses in WEEE-recycling are largely unaffected by tax regulations due to its informal status, the electronics production industry is highly subsidised and many facilities enjoy some form of preferential tax treatment.

In a global context, both industries do to some extent influence the future development of conflict risks: While the tight interrelations between the electronics industries in the Republic of China (Taiwan) and in the People's Republic of China are decreasing the risk of conflict escalation, the heightened demand for resources caused by skyrocketing production volumes is likely to give rise to international tension on mining concessions. In this situation WEEE-recycling is an important alternative source of raw materials, which still holds significant potentials for optimisation.

Currently there are between 2.27 and 6.3 million employees in the Chinese electronics production industry[21] – with numbers rising. Nevertheless the ongoing trends to product miniaturisation and process mechanisation do in some fields challenge employment creation in the long run, bearing the risk of job losses once the industry's upward trend is slowing down. The WEEE-recycling industry currently employs around 700,000 people in China. Since the industry significantly gains importance due to rising WEEE-volumes and heightened demand for raw materials, major job losses seem unlikely in the near future. Nevertheless the planed reorganisation of the sector creates some major uncertainties in this regard.

Both industries pose significant risks in terms of occupational health and safety and environmental pollution: While WEEE-recycling is widely perceived as a dangerous and polluting industry, electronics production still has a much cleaner and safer public image.

[21] The differences can partly be explained by the blurred boundary between the production of electronic and electrical products.

Nevertheless a review of related literature yields that both sectors feature some serious risk processes, while other processes are relatively safe for both, humans and the environment. For the future development of the two sectors in China it is vital to take the environmental and health and safety risks into account and work out ways to enable sound protection of people's health and the environment.

In terms of employment quality, workers in both sectors are to a significant portion subject to low wages, partly excessive overtime and the absence of functioning social security systems. While in the WEEE-recycling industry this situation is mainly caused by the sector's informal character, the electronics production industry is facing severe international competition leading to low profit margins and high pressure to reduce costs in any part of the supply chain. In order to improve the social impacts on workers, it is vital to insure their possibility to actively involve in business decisions that are directly affecting their working conditions.

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