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News and Commentary

Information and communication technology and environmental issues

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Abstract The three main areas where information and communication technology (ICT) impacts on the environment are considered: (1) the fallout from the processes of production, (2) the environmental burden of ICT products themselves and their use, and (3) the recycling and disposing of ICT products. On the basis of this overview, a number of environmental policies are proposed. A participatory system needs to be established between regional offi ces and all interested parties.

Key words ICT · Environmental disruption · Policy issues

Three environmental problems related to information and communication technology

A number of severe environmental problems stem from the utilization of information and communication technology (ICT); all are of major concern, and they can all be viewed from the standpoint of what is referred to as green ICT. The first concerns the environmental impact of the manufacture of ICT products and their associated parts. This process begins with the extraction of precious metals as raw materials and the environmental hazards that are associated with the mining of lead or copper, followed by further chemical contamination resulting from the production of semiconductors, a situation now referred to as “high-tech pollution.”

The second issue has to do with the energy demand levied by the use of ICT products themselves, and, in particular, the increasing demand for electricity requested by computer servers. Although manufacturers have improved the energy efficiency of single items, the increased number of ICT appliances in use negates the improvement: this is known as the “rebound effect.” Experts in developed countries have recently become more aware of this issue, and that we need to deal with the increasing energy demand under the umbrella of green ITC.

The third issue concerns the environmental problems that arise from the recycling and discarding of ICT products. Currently, in Japan, 5.3 million television sets are discarded annually, and half that number (2.2 million sets) are exported to such countries as Vietnam, the Philippines, and Macau (data from Japan Trade Statistics 2008). Although the situation for used ICT products and recycling is not clear, we know that as a result of the rapid spread of terrestrial digital broadcasting, a great many cathode ray tube (CRT) television sets quickly become unwanted used goods (BAN and SVTC 2002). Consequently, the establishment of a proper system for the collection and treatment of discarded sets is another major task. At a time when each individual country is establishing its own recycling system, clarifi cation of the quantities of used ICT goods being exported abroad and how this issue should be tackled are becoming matters of the utmost urgency.

Environmental impact of ICT production

The term “high-tech pollution” was coined in the 1980s to describe the serious soil and water contamination in the USA (Silicon Valley) and Japan caused by organic solvents used by the semiconductor industry. At the same time, the public became aware of occupational diseases suffered by factory workers as a consequence of the use by the factories of dangerous chemical substances. The large amount of water used by the high-tech industry continues to have a very serious impact upon agriculture and other industries.

What this means in reality is that semiconductor workers experience illness rates that are three times greater than do manufacturing workers in other industries. Three epidemiological studies carried out in the USA (Pastides et al. 1988; Schenker et al. 1995; Correa et al. 1996) found that women who worked in fabrication rooms have rates of miscarriage of 40% (or more) greater than nonmanufacturing workers.

Silicon Valley has more EPA Superfund sites than any other area in the USA (Smith 2009), but now that the high-tech industry and consequent pollution is spreading to Taiwan, Korea, China, and other East Asian countries, the present level of environmental technology transfer is inadequate. Recently, I visited two Science Industrial Parks in Taiwan (Xinzhu and Taichung), where more than half of the world’s semiconductors are produced. While a great deal of water is needed to produce liquid crystal panels, wastewater to agricultural and industrial activities has also increased and has added its own heavy burden on the environment (Tu and Lee 2009).

Great quantities of energy and material strength are required to produce semiconductors (Deng and Williams 2008). For example, in order to produce 2 g of DRAM chips with 32 MB of memory, we need 1.2 kg of fossil energy and 72 g of chemicals. Lawrence Berkeley National Laboratory (2006) calculated that during processing, 35% of the energy is consumed by the tools used for the processing itself, 46% for cleaning the processing room, 7% for liquid nitrogen production, and 5% for pure water production. While the amount of electricity used to produce one transistor has, in fact, fallen remarkably, and, for the 10 years from 1995 to 2005, actually fell by 98%, there has been no reduction in electrical power usage for central processing unit (CPU) manufacture because the number of transistors per CPU has increased at an exponential rate.

According to research conducted by the United Nations University (Kuehr and Williams 2003), the energy necessary to produce a desktop personal computer for private use is four times greater than that used by the computer when it is in operation. On the other hand, the energy required to produce a refrigerator is one-eighth of the energy needed to run the refrigerator in everyday use. It therefore makes sense to use the same personal computer for as long as possible so as to reduce the overall environmental burden. Yet because technological improvements in the design of personal computers have been so rapid, they quickly become obsolete. It therefore becomes necessary to control the resale and upgrading of used

ICT products.

The environmental burden of energy demands of ICT products

A United States Environmental Protection Agency (USEPA) report to Congress (USEPA 2007) estimated that in 2006, the energy consumed by the nation's computer servers and data centers came to about 61 billion kWh (1.5% of total US electricity consumption), for a total electricity cost of about $4.5 billion. This estimated level of electricity consumption is more than the electricity consumed by the nation's color televisions and is similar to the amount of electricity consumed by approximately 5.8 million average US households (or about 5% of the total US housing stock). During the past 5 years, increasing demand for computer resources has led to signifi cant growth in the number of data center servers, along with an estimated doubling in the energy used.

Such is the explosive growth in the distribution of information that by 2025, the amount is expected to be 190 times greater than the amount available at present worldwide. Inevitably, the amount of electricity consumed will also rise. The industrial development of countries such as Brazil, Russia, India, and China and their increasing use of ICT products is bound to contribute to the rapid increase of electricity consumption, and by 2025, overall consumption worldwide is expected to reach nine times the current level: this will amount to 15% percent of the world's electricity consumption and about 6% of the world's total energy consumption (Kameo 2008).

By 2025, Japan's energy consumption by ICT is expected to rise from 47 billion kWh to 240 billion kWh. Although it is estimated that the saving of energy by further technological innovation could amount to 99.5 billion kWh, Japan's absolute energy consumption will still amount to 140 billion kWh, which is too much. If we hope to ward off global warming, it really is necessary to reduce the absolute energy consumed by ICT.

Recycling and disposing of ICT products

While about 30% of discarded PCs in Japan are exported to developing countries [Japan Electronics and Information Technology Industries Association (JEITA) 2008], the recycling and disposal of other items of discarded ICT remains problematic, and because these operations often go undetected, the situation can cause the most serious environmental pollution.

If we discount mobile phones, which present their own problems, we note that in Japan, about 22 million items of the four main home electrical appliances—television sets, air conditioners, washing machines, and refrigerators—are discarded annually (Association for Electric Home Appliances 2008). Among these used products, about 11 million are collected and recycled; the remainder are sold in the domestic or overseas markets and recycled, but the actual situation is not at all clear. In the overseas market, many used products are utilized as second-hand products after adjustment of the voltage requirements, and although parts or certain metals from some of them are collected and ultimately recycled, the processes of recycling themselves cause environmental and occupational health problems.

Over the 2 years of 2007 and 2008, Japan shipped about 170 thousand tons of ICT equipment each year, and it is estimated that about 150 thousand tons of used ICT equipment will have been generated (JEITA 2008). Of this, PCs and peripheral equipment will have amounted to 97 thousand tons, while workstations will have accounted for about 60 thousand tons. As for the users, lease, rental, and sales to businesses accounted for about 100 thousand tons, while family users were responsible for around 50 thousand tons. We therefore estimate that domestic reuse is about 2000 tons, domestic resource recycling is 64 thousand tons, overseas exports (both exports of used products and scrap) are 37 thousand tons, and the final disposal is 8000 tons (JEITA 2008). We can see even from this brief survey that one quarter of domestic used ICT products are exported. Now that liquid crystal panels have recently come on to the used market, proper collection and treatment of the panels has become a serious issue. Because liquid crystal panels contain various chemicals, the generation of dioxin, in the case that the panels are thermally disposed, is another matter of great concern.

We may focus on four reasons for the export of used ICT to developing countries: (1) as a result of income differences, the market for used ICT in developing countries is relatively large; (2) because the cost of treatment in developed countries is relatively high, it pays to export used ICT to countries where the costs are lower; (3) in developing countries labor costs are cheap and environmental regulations are not strict; (4) the market for recycled material remains substantial. When we compare the recycling systems of the European Union (EU) with those of China and Japan, we observe that the Japanese Act for Recycling Specified Kinds of Home Appliances covers the four household items already mentioned. Used PCs from industry and households are handled under the Law for the Promotion of Effective Utilization of Resources. As for mobile phones, a topic we have not yet touched on, their disposal currently depends mainly upon voluntary efforts by the industry, and the fi gures are not encouraging. The rate at which used mobile phones are collected is decreasing, and is down to as low as 15%. China, meanwhile, has offi cially adopted a plan to integrate the domestic and multiple collecting of used home appliances and their subsequent processing, and this system will be implemented from 2011 (Yoshida and Yoshida 2008a).

The EU runs a system known familiarly by its acronym, the WEEE Directive, for the collection and recycling of electronic waste. This serves to collect both home appliances and ICT equipment at the same time, but the data shows that for each of its ten categories in 2005, only 28% of IT equipment and 30% of CRT televisions were collected. Under this system, the greater the number of used products that are collected, the greater the cost incurred by the manufacturers, while consumers are not provided with suffi cient incentive to participate in the collection system (United Nations University 2007). If this situation remains unchanged, we can therefore assume that the amount exported will be extremely large. A survey conducted in the Netherlands indicates that about one third of used television sets are exported (Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer Inspectorate 2007), while in the USA, where research development of ICT products is mainly carried out, no legislation at the federal level has been instituted and each state deals with its own issues independently. California has established an advanced fee payment system (SB20), while extended producer responsibility (EPR) has become routine. However, there are no landfi ll regulations for CRT machines and nor do actual regulations regarding exports exist (Yoshida and Yoshida 2008b).

Conclusions

ICT products may, if handled properly in line with green IT proposals, have the potential to save energy and reduce damage to the environment. However, should no changes be made in the current technology and the recycling systems, their actual environmental burden will grow greater. The use of virgin materials needs to be minimized and systematic environmental health assessments for new materials will have to be established. In terms of design, the potential for repair, reuse, and extended durability of products should be maximized, and better and more comprehensive recycling and decomposing methods should be considered. If we can implement such improved practices, we shall be able to evaluate more accurately the possible impact of the products on the environment, and thus on the health and wellbeing of society, while, at the same time, seeking to minimize any potential damage. Finally, we need to establish a participatory system between regional offi ces and interested parties with regard to the production and recycling of ICT products (Smith 2008). At the same time, cooperation with developing countries with regards to production and recycling is indispensable.

References

Association for Electric Home Appliances (AEHA) (2008) Annual report. AEHA, Japan

Basel Action Network (BAN) and Silicon Valley Toxics Coalition (SVTC) (2002) Exporting harm: the high-tech trashing of Asia. BAN, Seattle; SVTC, San Jose

Correra A, Gray RH, Cohen R, Rothman N, Shah F, Seacat H, Corn M (1996) Ethylene glycol ethers and risks of spontaneous abortion and subfertility. American Journal of Epidemiology 143:707–717

Deng L, Williams E (2008) Measures and trends in energy use of semiconductor manufacturing. Electronics and the Environment 2008. ISEE 2008. IEEE International Symposium, 19–22 May, pp 1–6

Japan Electronics and Information Technology Industries Association (JEITA) (2008) Research report on recovery, treatment and recycling of IT equipment. JEITA, Japan

Kameo K (2008) Green IT: realizing a low-carbon society. Eco Design2008 Japan Symposium 2008

Kuehr R, Williams E (eds) (2003) Computers and the environment: understanding and managing heir impacts. Kluwer, Dordrecht

Lawrence Berkeley National Laboratory (2006) Energy effi cient cleanroom information site. http://ateam.lbl.gov/cleanroom/technical.html. Accessed Jun 2010

Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer (VROM) Inspectorate (2007) The cleaner picture, enforcement action in 2006 on exports of waste electrical and electronic equipment. VROM Inspectorate, the Hague

Pastides H, Calabrese EJ, Hosmer DW, Harris DR (1988) Spontaneous abortion and general illness symptoms among semiconductor manufacturers. Journal of Occupational Medicine 30:543–551

Schenker MB, Gold EB, Beaumont JJ, Eskenazi B, Hammond SK, Lasley BL, McCurdy SA, Samuels SJ, Saiki CL, Swan SH (1995) Association of spontaneous abortion and other reproductive effects with work in the semiconductor industry. American Journal of Industrial Medicine 28:639–659

Smith T (Chairman of the advocacy group Electronics Take Back Coalition) (2008) Testimony in the Committee on Science and Technology in the lower house, 30 April

Smith T (2009) Challenging the chip: from clean-up to sustainability. 9th Asia-Pacifi c NGO Environmental Conference (APNEC 9), 20–21 November, Kyoto, Japan

Tu W, Lee Y (2009) Ineffective environmental laws in regulating electronic manufacturing pollution: examining water pollution disputes in Taiwan. 2009 IEEE International Symposium on Sustainable Systems and Technology, 18–20 May, Phoenix, AZ, pp 1–6

United Nations University (UNU) (2007) Review of directive on WEEE, final report. UNU, Bonn

United States Environmental Protection Agency (USEPA) (2007) EPA report to congress on server and data center energy effi ciency. USEPA, Washington, DC

Yoshida F, Yoshida H (2008a) Circular economy of China (in Japanese). Review of Environmental Economics and Policy Studies 1:14–25

Yoshida F, Yoshida H (2008b) WEEE recycling in EU (in Japanese). Journal of Environmental Technology Association 133:42–46