Reducing the Environmental Load by Using Information and Communications Technology

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Abstract

We examine the potential of information and communications technology (ICT) to reduce carbon dioxide (CO_2) emissions, the main factor in global warming, by reducing the movement of people and material. We estimate that CO_2 emissions in Japan in 2010 could be reduced by 2.8% through the use of electronic commerce, teleworking, intelligent transportation systems, and so on.

1. ICT and the global environment

The rapid spread of information and communications technology (ICT) including the Internet and mobile communications has accelerated the paradigm shift from an industrial society to an information-based society. ICT has a large influence on the environmental, economic, and social aspects of our lives [1]. As shown in **Fig. 1**, it has positive and negative influences on the global environment. One negative influence is the environmental load that the construction and operation of a telecommunications network creates by its use of energy and natural resources. On the other hand, ICT-based services could change lifestyles [2] and business models, resulting in a reduction of the environmental load.

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Several reports on the effect of information communication on carbon dioxide (CO_2) emission reduction have been published [3]. We extended the calculations to estimate how much the environmental load could be reduced by using ICT from both a micro perspective [4]-[6] and a macro perspective [7]. In this article, we discuss the total potential reduction of the environmental load that could be achieved by using ICT in Japan [8].

2. Quantifying the effects of ICT services in reducing environmental load

ICT could significantly reduce adverse impacts on the environment in three key ways:

(1) Making the distribution of goods more efficient
(2) Reducing the need for people to travel to make purchaces and conduct business
(3) Making production more efficient

We have developed a procedure for quantitatively

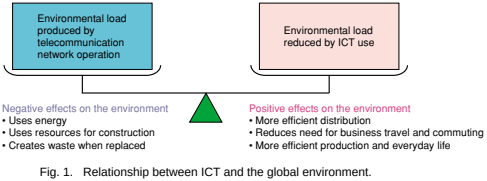

Fig. 1. Relationship between ICT and the global environment.

measuring the impact of videoconferencing, e-learning, and other ICT-based systems in reducing the environmental load [4]-[6]. We clarified that they have the potential to reduce energy consumption and CO_2 emissions by up to 90% [6]. In addition, we tried to roughly determine what effect the widespread deployment of ICT-based services might have on Japan's national CO_2 emissions. Using statistical data available in various kinds of white papers and other official publications, we developed a procedure for monitoring how much CO_2 emissions could be reduced by exploiting the advantages of ICT. We then applied these procedures to estimate the CO_2 reduction for the years 2001 and 2010.

We applied the formula to estimate the potential environmental benefits in the following six areas:

(1) Business-to-consumer e-commerce
(2) Business-to-business e-commerce
(3) Digitization of data transfer
(4) Teleworking, videoconferencing, and distance training
(5) Intelligent transportation systems (ITS)
(6) National and local e-government

(1) Business-to-consumer (B2C) e-commerce involves transactions between businesses and individual consumers over the Internet (**Fig. 2**). When transactions are conducted online, this effectively eliminates the need for wholesale and retail stores, so it substantially reduces the flow of goods to and from these different physical levels in the supply chain. Moreover, online ordering boosts made-to-order production, which reduces unnecessary production and the return of unsold goods. Although electronic commerce produces some increase in CO_2 emissions due to the increased volume of individual shipments and operation of warehouses, we expect the overall level of CO_2 emissions to be substantially cut. We attempted to estimate overall figures based on the reduced energy consumption from the wholesale industry in the industry-related table, proportion of total transactions that are conducted online, amount of energy saved from not driving cars, and so on. Based on these calculations, we estimated that CO_2 emissions were reduced by approximately 1.5 million tons in 2001 and will be reduced by 5.5 million tons in 2010.

(2) Further evolution of business-to-business (B2B) e-commerce will cut out intermediate warehousing through supply chain management and should significantly reduce CO_2 emissions by reducing business-related travel and eliminating other

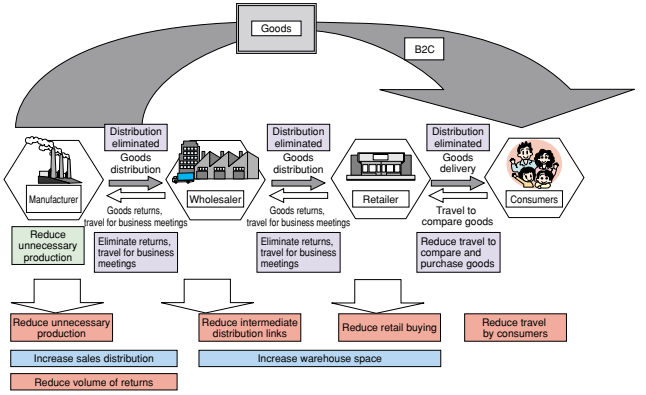

Fig. 2. Business-to-consumer e-commerce and reduction of CO_2 emissions.

wholesale-related operations. We estimate that in this area alone CO_2 emissions were reduced by about 3.2 million tons in 2001, and will be reduced by approximately 21.8 million tons in 2010. Of the six areas surveyed, B2B e-commerce offered the greatest prospect for CO_2 reduction and our projected figure for 2010 is equivalent to about 1.6% of Japan's national greenhouse gas emissions.

(3) Network delivery of content effectively reduces the CO_2 emissions associated with manufacturing and distributing physical recording media such as CDs and videotapes.

(4) Videoconferencing and teleworking reduce the need to drive cars and use other forms of transportation. We found that CO_2 emissions were reduced by about 800,000 tons in 2001, and we estimate that they will be reduced by approximately 3.1 million tons in 2010.

(5) Further deployment of intelligent transportation systems will reduce CO_2 emissions by relieving highway congestion and traffic jams, a major source of CO_2 emissions.

(6) Offering e-government services at both the national and local levels is another area that could sharply reduce CO_2 emissions through, for example, the use of electronic bidding procedures.

Table 1 shows how much CO_2 emissions could be reduced in six areas. Total estimated reduction of CO_2 emissions in 2001 was 6 million tons, which we project will increase to 34 million tons by 2010. These figures correspond to about 0.5% and 2.8% of Japan's total CO_2 emissions in the year 2000 (1.2 billion tons), respectively.

ICT has enormous potential for reducing the volume of CO_2 emissions. Clearly the key to exploiting this potential is to develop networks and information terminals that minimize adverse effects on the environment while promoting lifestyles and business models that mitigate society's impact on the environment.

Table 1. Projected reduction of greenhouse gas emissions through application of ICT.

	Service area	Effects			Reduced emissions* (10,000 tons CO_2)	
					2001	2010
1	Business-to-consumer e-commerce (online sales, convenience stores, network services, etc.)	Reduce need for intermediate distribution; reduce need for retail outlets, warehouse space, and sales distribution; reduce returns and curb excess production; reduce travel of consumers; reduce travel of consumers to convenience stores			153.7	550.9
2	Business-to-business e-commerce (supply chain management, application of ICT to reuse market, etc.)	Reduce travel of people, trains, and vehicles; eliminate middle wholesale layers; more efficient accounting and physical distribution; curb unnecessary production; streamline intermediate distribution; streamline retail distribution and reduce building space; reduce warehouse space and streamline sales and returns distribution; reduce need for vehicle parts, manufacturing and building equipment, and computers and other office equipment			326.0	2180.5
3	Digitization of data transfer (books, music, video, software)	Reduce need for intermediate distribution; eliminate retail sales; reduce warehouse space; eliminate brick-and mortar stores; reduce sales distribution; reduce returns distribution and production of media			1.3	215.2
4	Teleworking, videoconferencing, distance training	Reduce commuting and use of central office through teleworking; reduce travel through videoconferencing; remote management of vending machines			78.2	314.1
5	Intelligent transportation systems (ITS)	Reduce traffic congestion; infrastructure and vehicle mounted electronic equipment			28.4	114.3
6	National and local e-government (electronic bidding procedures)	Reduce need to travel			0.0	1.5
	Total				587.6	3376.5
			Breakdown	More efficient distribution	192.4	1280.5
				Reduced movement of people	196.5	553.0
				More efficient production	198.7	1543.0

* Energy balance tables for Japan.

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