

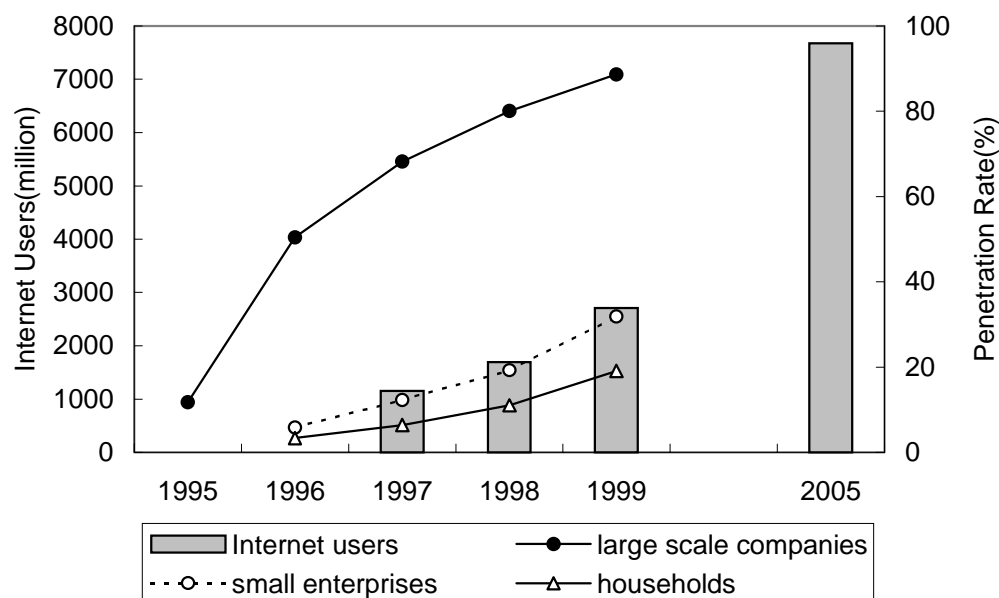
# GHG Emission Trends of the Internet in Japan: Indications to Facilitate Research

## 1. In Face of a Challenging Topic...

### 1.1 Global Warming and the Internet

It is estimated that some 27 million people were using the Internet in Japan at the end of 1999. This figure is about 1.6 times the estimated number for the previous year (Ministry of Posts and Telecommunications, 2000). As shown in Figure 1, the number of Internet users in Japan is most likely to continue burgeoning, and is expected to reach nearly 80 million in 2005 — more than 60 percent of Japanese connected to the Internet.

**Figure 1** Internet Penetration in Japan



**Source:** Ministry of Posts and Telecommunications, Communications Usage Trend Survey and Digitalized Lifestyles Survey, 1999

Such a dramatic increase in Internet users results in a substantial amount of new energy consumption that inevitably yields green house gas (GHG) emissions. This means that while today's emission from the Internet may only have a trivial impact on global warming, accelerated penetration of the Internet in Japan may soon emerge as one of major issues to be addressed in the discussion on climate policy. Thus, research to forecast and analyze future emission trends of the Internet will become increasingly necessary.

## **1.2 Objective**

It is, however, a challenge to estimate emission trends of the Internet. This is partly because the topic is in an emerging area of research and it is not clear what the most adequate methodology is to employ. A model simulation can be a useful tool for this topic, but careful consideration would be necessary in determining explanatory variables to be incorporated into a model. The current limited availability of data on the Internet serves as another reason. There is some relevant data being produced and made available, but, to date, most seem to be limited to Internet-related equipment familiar to the public, such as PCs and printers. A third reason is that it is difficult to estimate the growth of the Internet. Having entered the international market for mobile phones in 1992, the Finnish telecommunications company, Nokia, estimated the number of mobile phones over the world in 1999 at approximately 40 million; it turned out to be about 350 million (Nakatani/Takenaka, 2000). The difficulty in estimating would force a researcher to arbitrarily make a number of rough assumptions in constructing a simulation model.

Because of these difficult conditions, this paper aims at providing indications for facilitating research on emission trends of the Internet in Japan, rather than attempting an

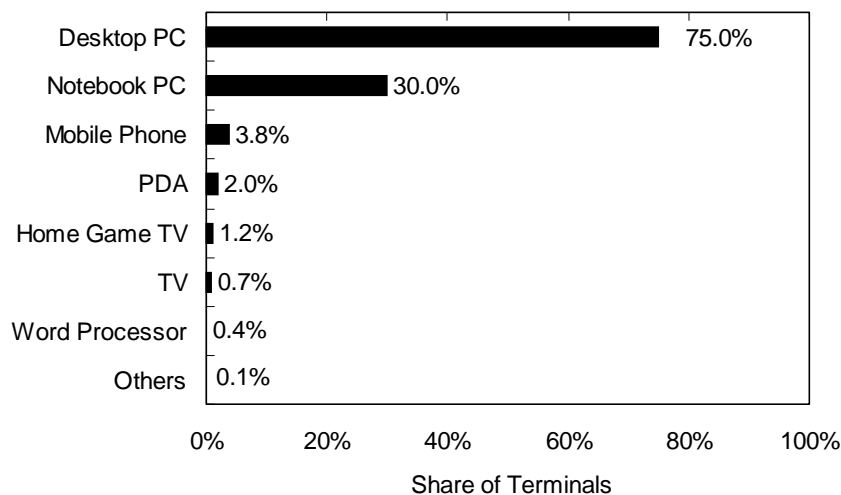
estimation itself. For this purpose, the following two issues will be discussed: 1) modeling energy consumption by the Internet, and 2) soaring use of the Internet.

## 2. MODELING ENERGY CONSUMPTION BY THE INTERNET

### 2.1 Defining the Internet as an Energy Consumer

What should be measured to estimate energy consumption of the Internet? A first step to answer this question is to clarify the composition of the Internet in terms of energy consumption. The Internet as an energy consumer may consist of terminals such as personal computers (PCs), printers, mobile phones, personal digital assistants (PDAs), and Internet TVs, as well as network infrastructure such as servers, routers, and hubs. This can be represented in the form of equation as follows.

**Figure 2** Terminals for Internet Use



Source: Ministry of Posts and Telecommunications, Internet User Survey, 1999

(1) *The Internet =*

*Terminals (PCs + printers + mobile phones + PDAs + Internet TVs, etc.) +  
Network Infrastructure (servers + routers + hubs, etc.)*

Figure 2 shows that among the terminals for Internet use in Japan, today, PCs are overwhelmingly dominant. On the other hand, other terminals occupy a minor area of the market.

## 2.2 Phases of Energy Consumption

Each component of Equation 1 consumes energy at basically four phases of its life cycle-- production, distribution, use, and disposal/recycling. To put this into an equation:

$$(2) \textit{Phases of Energy Consumption} = \\ \textit{Production} + \textit{Distribution} + \textit{Use} + \textit{Disposal/Recycling}$$

The combination of these two equations may provide a rough idea of energy consumption by the Internet. In other words, energy consumption of the Internet is the sum of energy consumption of the components of Equation 1 at the four phases of Equation 2.

## 2.3 A Simple Model Example

To step further, an example for calculation is shown below. The following simple model may achieve an approximate estimation for electricity consumption of PCs in the use phase.

$$(3) Y = X_1 \times X_2 \times X_3$$

$Y$  = electricity consumption of PCs in use per day (watt)

$X_1$  = average electricity consumption of a PC per hour (watt)

$X_2$  = average usage in hours of a PC per day (hours)

$X_3$  = total number of Internet users (people)

Since this is a very simple model only with very major explanatory variables, there are many factors to be considered in actual calculation. For instance, the fact that PCs in use have different patterns of electricity consumption caused by their different modes, namely, active mode, stand-by mode, and off mode, would need to be incorporated into the calculation for  $X_1$ , average electricity consumption of a PC per hour. Also, the trend of the increasing number of PCs constantly connected to the Internet would need to be taken well into account when measuring  $X_2$ , average usage in hours of a PC per day.

These factors for consideration, as well as the explanatory variables of Equation 3, would vary depending on the explanatory variables of Equation 1, or the components of the Internet as an energy consumer. This is because, for example, the explanatory variable, average usage in hours, is not needed for an estimation for network infrastructure, which is basically active all the time.

It is clear that a set of the above equations is too simple to fully create a model of energy consumption by the Internet. It is therefore encouraged establish more realistic criteria and to collect the necessary data for a simulation analysis.

### ***3. SOARING USE OF THE INTERNET***

#### **3.1 For Better Assumptions...**

To have a good sense of estimating the future is critically important for research on GHG emission trends of the Internet, as making assumptions on uncertain figures such as growth rate of Internet use and speed of technology innovation is essential in constructing a model. Nonetheless, it is extremely difficult as the example of Nokia, introduced above, evidently

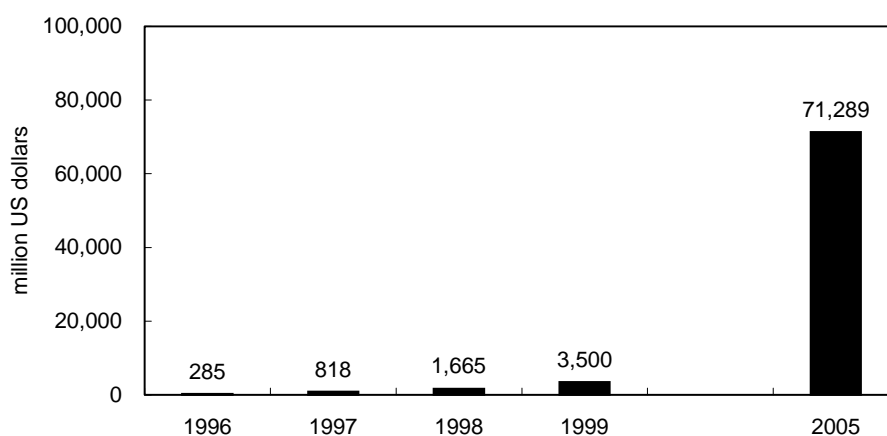
demonstrates—even experts in the field made a mistake of underestimating a number by nearly one tenth.

In order to help make better assumptions for a simulation model, this section lays out particularly significant data and discussions associated with today's situation and prospects of the Internet in Japan.

### 3.2 Internet Commerce

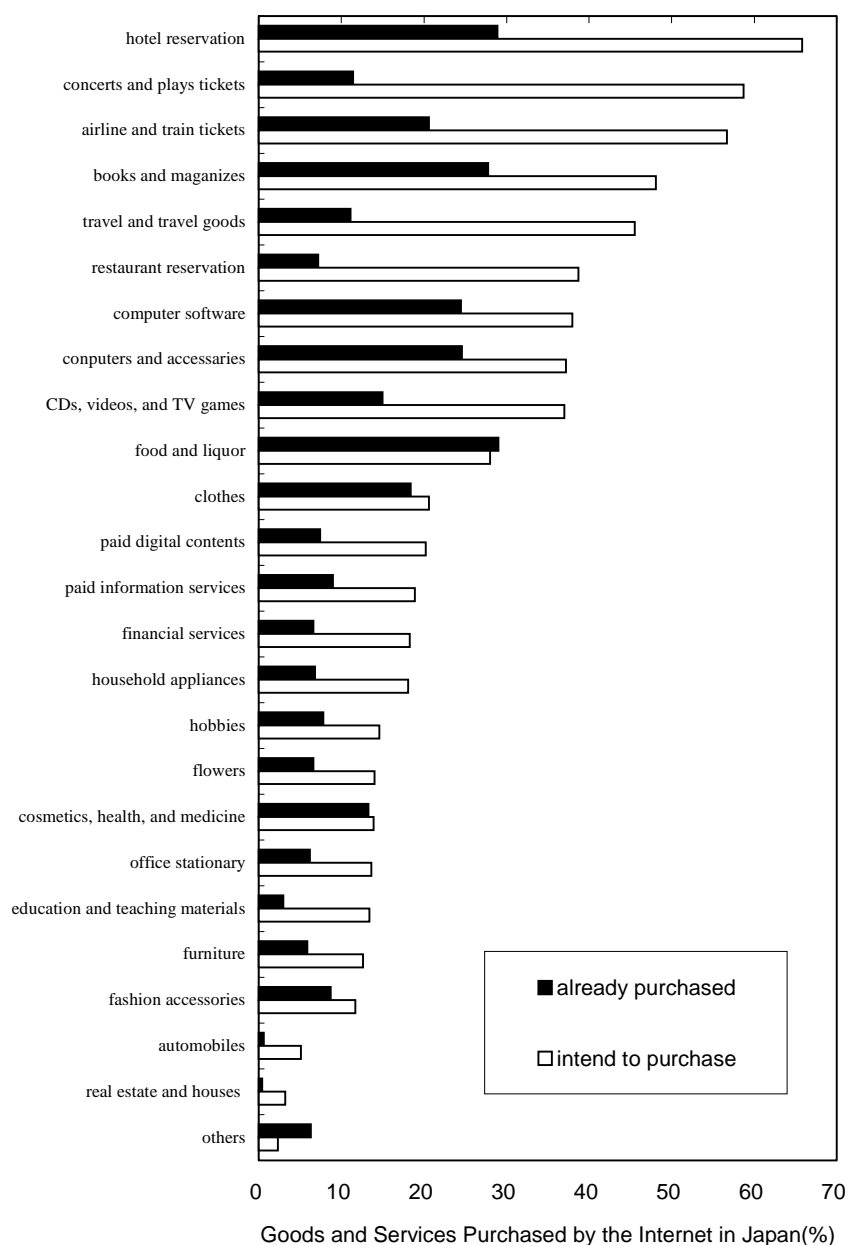
Probably the most powerful driver of Internet use is the rapidly expanding area of Internet commerce. As shown in Figure 3, Japan's market size for final consumption of goods and services online in 1999 is about 3,500 million US dollars, which is more than double when compared with the previous year. This figure accounts for 0.06 percent of the nation's total final demand, and indicates that in 1999 one Japanese Internet user spent slightly below 130 US dollars for online shopping. It is estimated that the online amount will skyrocket, exceeding 70 billion US dollars in 2005.

**Figure 3** Market Size for Final Consumption Goods by Internet Commerce



**Source:** Ministry of Posts and Telecommunications, Internet Commerce

Figure 4 illustrates the percentages of Japanese Internet users having already purchased a variety of goods and services via Internet, as well as of those with intention to purchase the same goods and services in the future. Overall, considerable growth of Internet commerce is anticipated. Specifically, a dramatic increase in demand is likely in such goods and services as hotel and restaurant reservations, concert and transportation tickets, and books, magazines, and music CDs.

**Figure 4** Goods and Services Purchased by the Internet in Japan

Source: Ministry of Posts and Telecommunications, Internet User Survey, 1999

### 3.3 Digital Government and Digital Household Appliances

While the private sector promotes Internet use by developing Internet commerce, the public sector also contributes to advance the prevalence of the Internet through establishing a



digital government. A survey conducted by the Management and Coordination Agency of Japan has indicated that there are currently a total of 9,089 administrative procedures, including applications and reports to the central government. The Japanese government set a goal to achieve digital processing for all these procedures by 2003. As the media for administrative procedures move from paper to the Internet, demand for Internet use is naturally enhanced, thereby increasing energy consumption of the Internet.

Also, a newspaper article at the end of last September reported that approximately 80 municipal governments in Japan are planning to launch a new service by 2002 that allows citizens to pay local taxes via the Internet and ATMs.

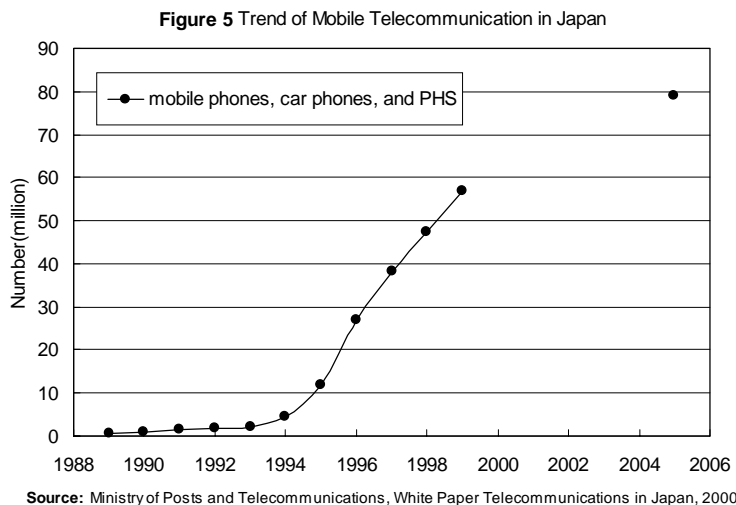
Another possible major booster of energy consumption by the Internet is digital household appliances. Once TVs, DVDs, refrigerators, and air conditioners are connected to the Internet, part of the energy consumption of these appliances will be considered as energy consumption of the Internet.

The Japan Electronics and Information Technology Industries Association estimates that domestic demand for digital TVs with tuners will sharply rise and reach nearly 350 million in 2003.

### **3.4 Mobile Internet**

As shown in Figure 2, PCs (both desktop and notebook) have been the sole major terminal to connect to the Internet to date. Mobile phones, the second top terminal for the Internet, are used only by 3.8 percent of the total number of Japanese Internet users.

What could be called a mobile revolution seems to be underway, however. Figure 5 indicates a striking growth in mobile telecommunications since 1995 in Japan. In 1999, 56.85 million mobile telecommunication devices



were sold in Japan, and by 2005 this number is estimated to reach roughly 80 million—more than three out of five Japanese will use mobile telecommunications services.

In comparison with fixed phones, the total number of mobile phones in Japan exceeded that of fixed phones at the end of 1999, as Figure 6 shows. In contrast with the rapidly growing number of mobile phones, the total number of fixed phones continues to gradually decline.

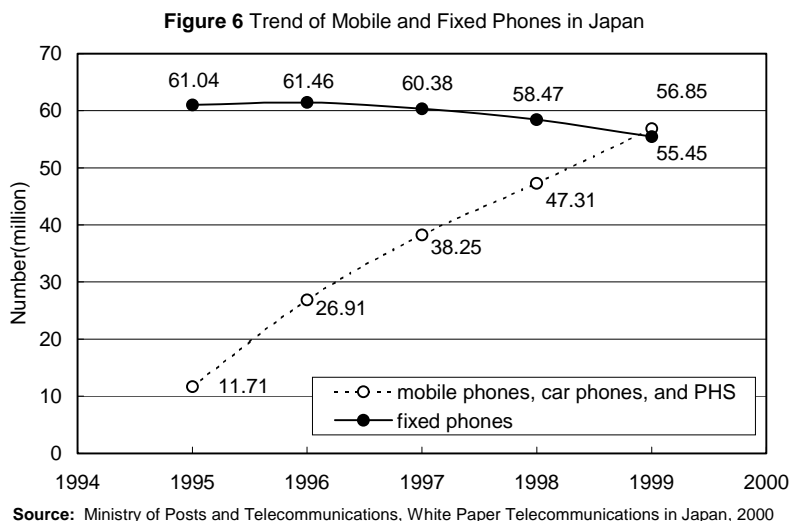
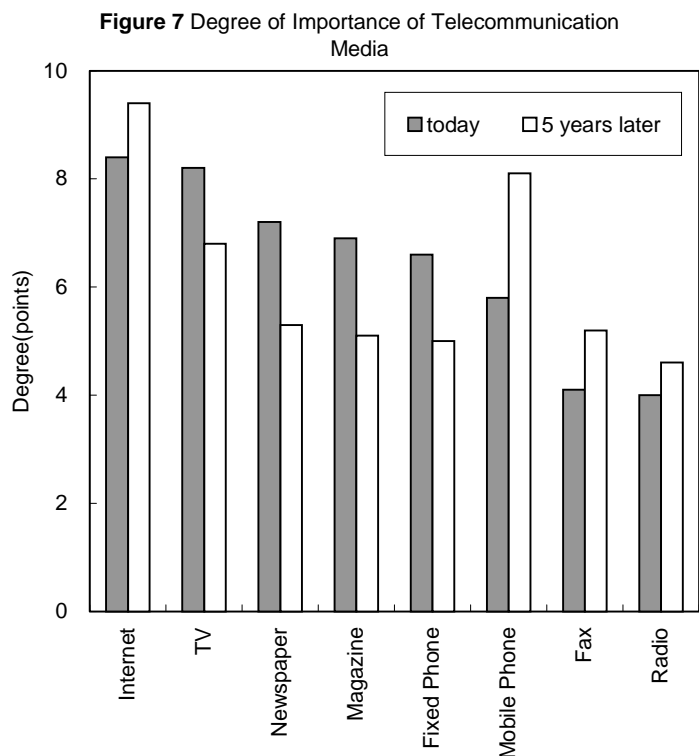
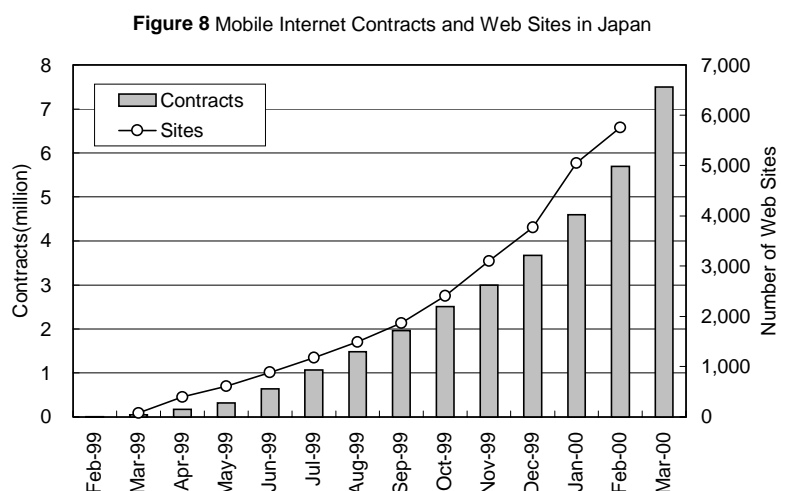


Figure 7 shows to what degree Internet users in Japan regard different telecommunication media as important. Each media was graded by Internet users on a 10-point scale. New media such as the Internet and mobile phones received higher points for 5 years later, while conventional media represented by TVs, newspapers, magazines, and fixed phones were graded lower for the future than today. What is most notable here is a sharp upgrade of mobile phones, which were given 8.1 points for 5 years later from 5.8 points for today. Coupled with the Internet with 9.4 points, mobile phones are likely to appear as a major media for telecommunication in the near future.



Source: Ministry of Posts and Telecommunications, Internet User Survey, 2000

In February of 1999, mobile phones were designed to facilitate access to the Internet and provided a variety of information services such as news, weather forecasts, and restaurant guides. Since then, as seen in Figure 8, the use of mobile Internet has been soaring in Japan. Because of its portability, lightness, and



Source: Ministry of Posts and Telecommunications, White Paper Telecommunications in Japan, 2000

easiness to use, mobile phones have caught a wide range of new users, and at the same time, a large variety of web sites specifically designed for mobile Internet use have been rapidly developed.

Given that electricity consumption per mobile phone is very small among Internet components, mobile phones may be treated only as a minor factor in estimating GHG emission trends of the Internet. Suppose, however, that technology innovation will soon allow mobile phones to have various elaborate functions, such as transmitting motion pictures. This can be attained by consuming increased amounts of electricity. People may also want to change their mobile phones more frequently than today because of the attractiveness of such functions. The result of this would be total energy consumption of mobile phones that is not negligible. Mobile phones will certainly soon become a major terminal for the Internet, and thus the impact of this emerging tool would need to be examined.

#### ***4. THE INTERNET AS AN ENERGY SAVER***

All through the discussions above, the fact that the Internet consumes energy and thus contributes to global warming is taken for granted. Accelerating Internet commerce, promoting digital government, increasing digital household appliances, and exploding use of mobile phones - all of these topics have been discussed under the premise that the Internet is an energy consumer. This was half-correct.

The Internet and its wide applications have the potential to change the conventional patterns of our economic and social systems, in the direction of lowering energy consumption of the society. For example, enhanced use of the Internet may alternate trips to

bookstore or government office to telecommunication, causing a reduction in energy consumption for transportation. Further prevalence of automobile navigation systems may cut gasoline consumption by helping evade traffic congestion and decreasing the potential for losing one's way.

Although not easy, quantifying such positive effects of the Internet may serve as an interesting research topic that is deeply associated with GHG emission trends of the Internet.

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## REFERENCES

- Japan Internet Association, Internet (2000): Hakusho 2000 (Internet White Paper 2000): Impress.
- Ministry of International Trade and Industry, Bureau of Machine, Information, and Industry (2000): Pasokon Hakusho 2000-2001 (The White Paper of Personal Computer 2000-2001), Computer Age.
- Ministry of Posts and Telecommunications (2000): Heisei 12 Nendoban Tsushin Hakusho (White Paper Telecommunications in Japan), Gyosei.
- Ministry of Posts and Telecommunications (2000): White Paper Telecommunications in Japan 2000,
- Nakatani, Iwao and Heizo Takenaka (2000): IT Power: Ninon Keizai Shuyaku no Koutai (IT Innovation: a change of the Japanese Economy and its Main Actors), PHP Kenkyujo.
- OECD (1999): Communications Outlook 1999, OECD.
- OECD (2000): Information Technology Outlook 2000, OECD.