S-3 Low-Carbon Society Scenario toward 2050: Scenario Development and its Implication for Policy Measures

4. Integrated Measures of Technologies and Lifestyles against Global Warming - Ecodesign of ICT (Information and Communication Technology) Society -

(Abstract of the Final Report)

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I. Overview

We have been studying the influence of ICT diffusion on environmental problems. From previous study's results, we selected three important ICT applications. These are an "SCM (Supply Chain Management) system", which reduces resources used in the industry sector, an "advanced traffic utilization system & teleworking", which increases energy use efficiency and decreases the frequency of traffic use, and an "Eco-life navigation system", which changes people's actions to a more environmentally conscious one. We investigated these effects on environmental loads in more detail. We estimated ICT impact on CO_2 reduction in 2020 and 2050 based on previous results. These values were estimated according to uniform social change. However, pattern of changes will not be uniform, due to the radical nature of ICT revolution. We therefore investigated how to depict future ICT society post ICT revolution, and after that we made the second estimation in 2050. Figure 1 shows the flow of our creation method of a 2050 sustainable low carbon society. As shown, 1000 citizens were surveyed on 11 categories: ex. eating-style, working-style, living-style in 2050. Information on future life style was gathered by examining SF-films and animation, and consulting over ten knowledgeable people and two research groups. These ideas were then brainstormed in order to construct a vision of a future-desired ICT society based on a new 'social model' which represents the relationship between human society and technology. A presentation of the future-desired ICT society was created using text and illustration focusing on lifestyle in 2050. We also studied ICT impact on industrial structure in 2050, using a macroscopic long-term simulation model and microscopic LCA based model.

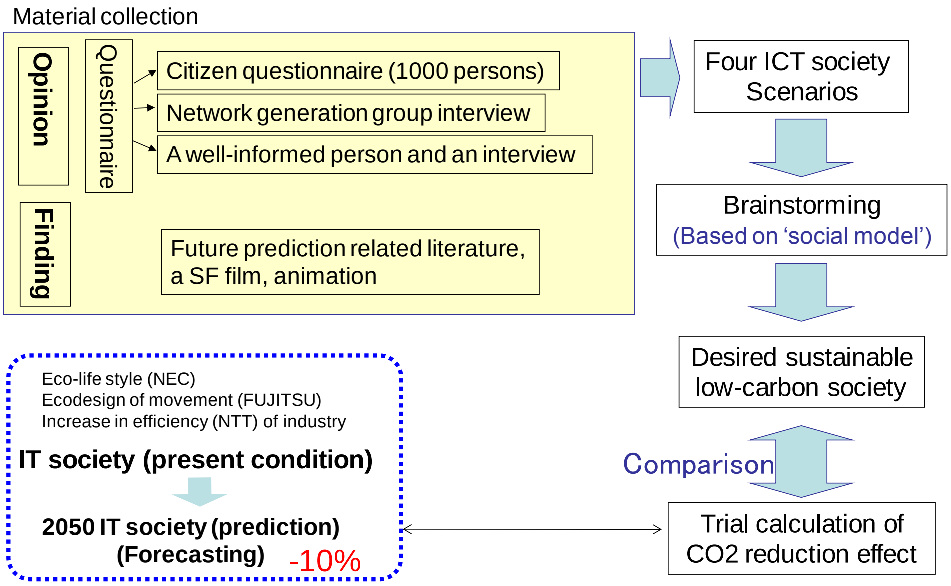

Fig.1 Creation method of 2050 social images

II. Scientific outcome

In this paper, the impact of ICT on a Low Carbon Society with regard to the possibilities of social structural change and holistic methods of application were studied. The results can be summarized as follows.

1. New 'Techno-ontological approach' based on radical methodology depicting the desires of people was developed.
2. A presentation of the future-desired ICT society was created using text and illustration focusing on the lifestyle in 2050.
3. New post ICT revolution society makes it possible to reduce CO_2 emission to over 20 percent in comparison to Japan's total CO_2 emission in the year 2000.
4. The compatibility of drastic CO_2 emission reduction and a desired sustainable lifestyle was suggested.
5. CO_2 reduction effect of only -10% was obtained by forecasting without considering paradigm shift in social structures.
6. 'Techno-ontological approach' which considers the fusion of technology and mental /emotional matters is needed in order to deal with the problem of over consumption and to realize a truly sustainable low carbon society.
7. The impact of ICT on economy, e.g. 'Offshoring', may have a positive impact on decreasing CO_2 emission in Japan. On the contrary, in global viewpoint, the ICT may have negative impact on increasing CO_2 emission in the world.

III. Contribution to policy of global environmental issues for decision makers

1) ICT has been taken up as an essential countermeasure for achieving a low carbon society in recent years by a number of ministries such as the Ministry of Economy, Trade and Industry,

Ministry of Internal Affairs and Communications, Ministry of Land, Infrastructure and Transport, and Ministry of Environment. In relation to this policy making, our activities for this research program have contributed largely in recognizing the positive impact of ICT on global warming issues.
2) ITU-T (International Telecommunication Union Telecommunication Standardization Sector) has started the standardization of the evaluation methods of the impact of ICT on global warming from the last fiscal year. Our research team members have contributed as major members.

1. Introduction

Industry tries to manufacture highly functional goods cheaply and in large quantities. Consumers then purchase a comfortable lifestyle supported by large resource consumption. This cycle has caused several kinds of environmental problems. “Global warming” is a typical one. Against this background, symptomatic treatment of the individual conditions of environmental problems would not produce any demonstrable results with respect to either the environment or the economy. We should instead tackle a causal approach and reform industrial activities and lifestyles, which are the root cause of the problem, by transforming them into new activities and lifestyles whose environmental loads are smaller. The first great step to prevent global warming was taken by Kyoto Protocol which came into effect on Feb.16, 2005. But it is necessary to reduce GHG (Greenhouse gases) emissions drastically to stabilize climate. It would be possible to propose concrete policy packages including institutional change, technology development, and lifestyle change toward low carbon society. The research project on “Establishing of Methodology to Evaluate Middle to Long term Environmental Policy Options toward Low Carbon Society in Japan (Japan Low carbon society scenarios toward 2050) “ has been conducted in order to assess its long-term global warming policy1-2. This project focuses on the following issues: 1) long-term scenario development study to integrate environmental options consistently using simulation models, 2) long-term GHG reduction target setting considering effectiveness and validity, and 3) assessment of environmental options considering future socio-economic conditions in a)urban system, b) information communication technology (ICT) society and c) transportation system. This research focuses on one research issue: ICT influence on Low Carbon Society with regard to the possibilities of social structural change and methods of application.

2. Research Objective

With the development and diffusion of information and communication technologies (ICT), we can obtain various benefits in all aspects of society. In industry, we have obtained efficiency improvements in materials supply, physical distribution, and office work, and achieved the globalization of business. In daily life, we have obtained many benefits from novel approaches to communication with other people, information acquisition for hobbies and entertainment, and the purchase of commodities. These changes are expected to accelerate with increasing communication capacity and simplified access to networks in the future. Great structural changes in society will occur (i.e., an ICT revolution).As the consumption of resources depends on the social structure, the

ICT revolution will make it possible to exert a large influence on the environmental load of society. At present, as we start moving toward an ICT revolution, adding environmental consciousness will lead to the causal treatment of environmental problems, which will in turn reform industrial activities and lifestyles through more sustainable approaches (Fig. 2). This is our research perspective.

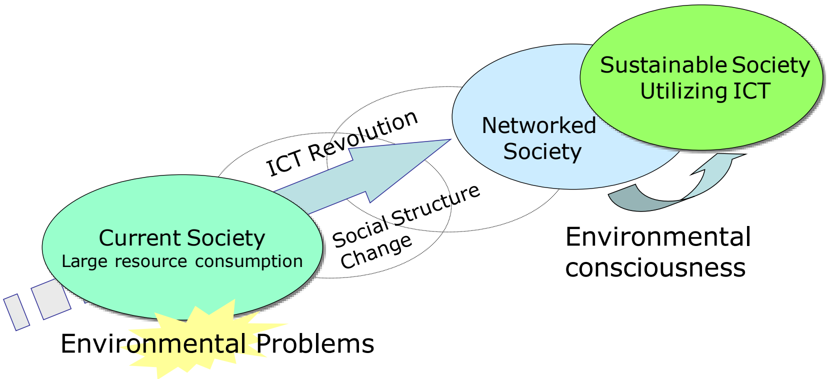

Fig.2 Ecodesign of ICT Society

3. Results and Discussion

(1) How much CO_2 can be reduced by utilizing ICT

It is difficult to estimate the CO_2 reduction by utilizing ICT quantitatively. The reason for this is that the effect of ICT is indirect and too diverse spread over, for example, production, distribution, and sales. However, many research institutions have estimated the CO_2 reduction effects of 2010, and found a CO_2 reduction of 2-3% of Japan's total emission (Matsumoto et al, 2005), (Nakamura et al, 2003). Furthermore, the reduction effect of 2020 was also clarified in this research project. The results were as follows:

-By introducing HEMS etc. it would be possible to reduce CO_2 by 15-20 million tons in the commercial and domestic sector in comparison with 2000 year's emission (Matsumoto et al 2007).

-By encouraging the use of public transportation systems it would be possible to reduce CO_2 by 10million tons in the transportation sector (Ueda et al, 2004).

And finally by introducing SCM systems it would be possible to reduce CO_2 by 47 million tons in the industrial sector (Origuchi et al, 2005).

In addition to these reduction effects, it is necessary to consider the negative impact, and then evaluate total reduction effect i.e. 5 % reduction in comparison with Japan's total emission in 2000. Table 1 summarizes these results for around the year 2020. The first column shows typical ICT applications, for example, internet shopping, tele-working, and so on. The following columns show the impact in each individual sector. The last column shows the impact forecast from previous studies regarding the impact in the year 2010. These numerical values, which indicate ICT impact in the year 2020, were obtained from our studies.

In 2050, we expect more CO_2 reduction due to ICT, its value increasing from 5% in 2020 to 10% in comparison to Japan's total emission in 2000 year. It must be noted that the above argument is based on ICT used within conventional social systems, and the values were therefore estimated according to a uniform pattern of change. However, due to the radical nature of an ICT revolution, the pattern of change will not be uniform, that is, there will be a paradigm-shift in technological and social structures. As stated by James Lovelock, “An ultra-high-tech low-energy civilization may well be possible, but it would be wholly different from the present-day vision of a low-energy world of sustainable development and renewable energy” (Lovelock, 2006). It is therefore necessary to examine how a future society post ICT revolution can be depicted, and by doing so gain a more accurate insight into the impact ICT diffusion will have on CO_2 emission. After this examination a second estimation of carbon emission in 2050 can be made.

Table 1 Future impact of ICT in 2020

	Industry	*Freight transport*	*Passenger transport*	*Office*	*Home*	*Recycling*	*Impact on CO2 emmisions*	
Diffusion of ICT equipment	Resource consumption			Electric power	Electric power	Waste	**Negative II**	+1to2%
Supply chain management (B2B)	Resource consumption	Transport					**Positive I**	-3%
Internet shopping (B2C)	Resource consumption	Resource consumption		Number of shops			**Negative/Psotive**	
Teleworking			Transport	Number of offices	Electric power		**Positive III**	-1%
Advanced traffic utilization system (modal shift in commuting, ETC, etc.)		Transport	Energy consumption				**Postive II**	
Dematerialization system (newspaper, magazine, and CD)	Resource consumption	Transport		Number of shops		Waste	**Positive III**	-1%
Energy-management system (HEMS, BEMS)				Electric power	Electric power		**Positive II**	-1to-2%
Eco-life guidance system			Energy consumption	Electric power	Electric power	Waste	**Positive I**	
A product and manufacture management	Resource consumption						**Positive I**	
Recycling information system	Resouce consumption					Waste	**Negative/Psotive**	
E-government			Transport			Wastes	**Positive III**	

Reduction
Increase
Unknown

	Rate to the total 2020' emissions
I	3-5%
II	1-3%
III	0-1%

(2) Impact of ICT on Society.

The environmental influence of ICT was described above, and it was found that ICT diffusion can help decrease CO_2 emission. However, if an ICT revolution is to take place i.e. ICT diffusion leading to social structural change, we must be aware of the impact ICT will have on society, especially with regard to the mental/emotional condition of its citizens. As Nobert Wiener said, it is important to ‘examine ways in which Information and Communication Technology can affect -both positively and negatively- fundamental human values.’ (qtd. in Bynum). Possible negative effects, such as the ‘rebound effect’ have already been mentioned, but if we are to depict a sustainable, desired low carbon society in 2050, a deeper investigation into how these conditions may contribute to the culture of over-consumption prevalent in today’s society must be carried out. Advances in technology have had a profound effect on society, but history has also shown how such technology has led to the dissolution of fundamental traditional values such as ‘family’, ‘community’, ‘morality’ and ‘spirituality’. `Much of the social history of the nineteenth and twentieth century is the story about the dissolution of community and family connections.

Moreover, much of this decline in face to face social connectedness has arisen from one technological change after another` (Nie et al). Similar to an ICT revolution, the industrial revolution, for example, brought about major technological, socioeconomic and cultural changes throughout the world. However, as well as the obvious positive impact, it has been argued that the Industrial Revolution undermined many traditional values that are fundamental to the mental/emotional well being of people. For example, mass migration of families from rural to urban areas saw a decline in living conditions in the city. Workers had to work long hours without the traditional breaks which existed in agricultural communities such as Harvest time. Indeed, people's bond with nature-physical and spiritual was eroded. Before the Industrial Revolution, work based in the rural community was often shared by both the husband and wife and family duties such as raising children and transmitting traditional values and morals were the responsibility of the whole family unit, including grandparents. Also, significantly, mass production encouraged mass consumption and the dramatic increase in fossil fuel usage gave rise to the exhaustion of natural resources and massive increases in atmospheric pollution.

We must therefore consider not only how ICT diffusion affects the environment, but also how the application and usage of ICT affect the mental/emotional condition of people within society, which in turn may have an indirect impact on the environment. Figure 3 describes a 'Technological Approach' to understanding the effects technology has had on mental/emotional conditions. In this 'Technological Approach' priority is on the technology itself, without considering the impact such technology has on mental/emotional, social and environmental conditions.

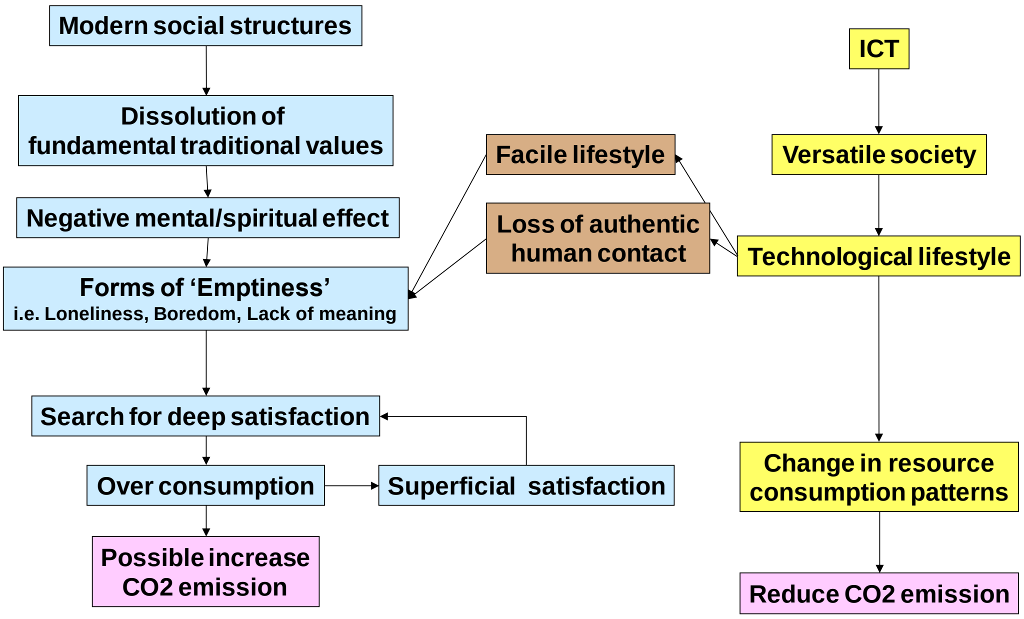

Fig.3 Current Social Disorder-Technological approach-

Currently, ICT diffusion can help create a versatile society in which changes in resource and consumption patterns lead to a drastic reduction in CO_2 emission. However, we can also see the possible negative impact ICT could have on the mental/emotional condition of people within an ICT society if a 'Technological' approach is taken i.e. utilizing technology without social and environmental consciousness.

As shown in Fig 3 it can be argued that the gradual dissolution of fundamental traditional values such as family, community, morality within society has led to negative mental/emotional conditions, creating forms of ‘emptiness’, such as loneliness, boredom, lack of meaning. People try to superficially fill this ‘emptiness’ by consuming products, which in turn accentuates feelings of ‘emptiness’, leading to more consumption thereby further adding to the culture of over-consumption already existing in today’s society. Although it is true that ICT did not directly create these negative conditions, ICT such as the internet ‘follows a long string of technological innovations so that each had the unintended consequence of reducing the number and meaningfulness of emotionally gratifying face to face human interactions’ (Nie et al). Fig 3 shows that if current approaches to ICT utilization are continued, the following two key ICT related issues could produce a negative impact by accelerating various forms of ‘emptiness’, and thus encouraging over-consumption.

Facile Life-style.

Facile lifestyle encourages the mass consumption of resources and energy by making it easier to consume. Internet shopping, for example, makes buying products convenient. From the comfort of an armchair, products from all over the world can be bought. Shopping can be conducted 24 hours a day, 7 days a week. Does the ease by which things can be done reduce feelings of satisfaction? Can having more free-time lead to feelings of boredom as well as a lethargic and excessive lifestyle? Although solid research on these issues is scant, these are questions that should nevertheless be considered when attempting to create a scenario for a sustainable, emotionally healthy low carbon society.

Loss of Authentic Human Contact.

The use of ICT can make global communication easy and convenient, but how ‘authentic’ is such communication? Can people truly feel ‘touched’ by others through e-mail, or internet ‘chat-rooms’? If we can shop and work from the comfort of our own homes via internet technology, does this mean we go through the whole day without physically meeting anyone? In her study ‘Current Societal Problems with Mobile Phone Usage in 15 countries’, Keating describes how cell phones have changed social habits of visiting friends and relatives and that people complain they now receive text messages rather than visits (Keating, 2005). It appears that face to face contact is important for measuring emotions and understanding feelings. In a number of studies it has been shown that `internet use at home has a strong negative impact on time spent with friends and family` (Nie et al). The negative impact that feelings of isolation and loneliness can have on the mental/emotional condition of people can be profound, leading to an increase in mental disorders and perhaps even the loss of moral values. A study by Qi Jiayin at Beijing University, revealed that mobile phone users are inclined to not tell the truth while talking on the phone, for example, ‘pretending to work when in fact they are having dinner’ (Jiayin, 2007).

Both a facile lifestyle and the loss of authentic human contact could accelerate various pre-exisiting ‘forms of emptiness’, creating a mechanism that has formed the backdrop for the current global warming problem. Perhaps a useful example that serves as a suitable analogy for all resource/energy over consumption issues is the condition called “Hyperphagia” or over-eating disorder. The mechanism shown in Fig. 4 shows the inter-relationship between society, environment and the economy. Over-eating disorder requires “excessive food consumption”, leading to the problems of disease and obesity, thereby creating “Excessive Demands”, such as medical and exercise services. What is the root cause of `over eating disorder`? Its root cause is said to be mental disorder. Similarly, in societies of developed countries, people purchase products excessively in order to fill their feelings of `emptiness` i.e. mental disorder. This leads to the expansion of manufacturing industries and other industries which are linked to such purchased products. Like people suffering from Hyperphagia, people who purchase products rapidly lose their sense of satisfaction, and therefore purchase more products to refill their feelings of `emptiness`. It could be said that this mechanism arises out of the breakdown of social structures: a ‘sick society.’ Perhaps by curing this ‘sickness’ it is possible to break the mechanism and thus reduce resource and energy consumption.

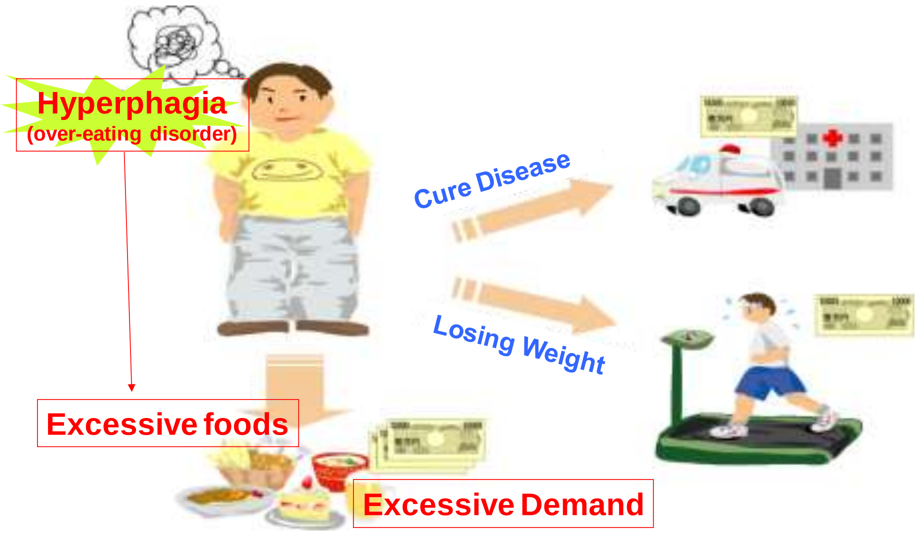

Fig.4 Resource and Energy Over Consumption

What role can advanced ICT play in curing this ‘sickness’? Whereas current levels of ICT can have a negative impact on social structures, is it possible for future advanced levels of ICT to provide solutions, such as creating more meaningful and ‘authentic’ encounters amongst family and friends?

(3)Toward depicting a low carbon-society by utilizing ICT

The rapid progress of ICT makes it difficult to imagine what kind of ICT will be developed and how such advanced ICT will be disseminated in 2050. However, by examining the dreams and desires of people with regard to a future society, it becomes possible to understand how to utilize and develop advanced ICT in realizing such a society. In this study a type of “back-casting” method is required. In a ‘back-casting’ method, it is first necessary to set up an image of the ideal-future society which is to be reached, and then to look back upon the present society from the standpoint of this future image. Finally it is necessary to examine how it is possible to reach this ideal-future from the present society. In this method, how to depict the ideal-future society is essential.

1) Methodology depicting future desired society

In order to depict a future desired society, 3 methods were used: an intuitive method, a scenario-planning method and a brainstorming method based on questionnaires regarding future life-styles.

First, both the intuitive method and questionnaires were used to gather a number of key words/concepts related to future life-styles. Five science-fiction movies and nine animations which described future societies were examined. This type of material contains a wealth of images depicting future societies, and although these images were based only on the intuition of the artist, many have already been actualized in the present world. As Mike Alsford states in his book ‘What If’: “Future fiction focuses its attention upon issues relating to humanity’s utilization of technology and its long-term effects upon the human condition” (Alsford, 2000). As well as this intuitive method, a questionnaire examining 11 categories in daily life scenes was conducted on over 1000 citizens and 18 experts from various fields.

Two kinds of questionnaire were used. The first asked forty ‘Yes’ or ‘No’ questions regarding future life style. Examples of the questions asked were as follows: *‘By stimulating the cerebral nerve, will people be able to control their emotions?’ ‘Will advanced ICT enable people to work anywhere, allowing people to live and work in a resort location?’*, and so on.

The second questionnaire asked ten ‘open’ questions in which the subjects were allowed to answer in detail. For example, ‘*What do you think about life (dwelling, wear, housework, transportation, education, and so on) in 2050?*’

The key words were gathered from these 2 approaches and then organized into individual life scenes, e.g. learning, working, eating, shopping and so on.

2) Four future ICT scenarios sketched

Using these keywords/concepts and the scenario-planning method, future ICT society scenarios were sketched. In this method, essential future uncertain factors were chosen and the swing of these factors guided several kinds of future societies. Two uncertain factors were chosen and each uncertain factor was expressed by two axes and four quadrants. The future society scenarios below were then placed in each quadrant. The two chosen uncertain factors were governance (dependence or independence) and personal life-style (pursuit of private desires or natural/public-spirited). The four future ICT scenarios were created by using the above key words and brain storming (Fig.5).

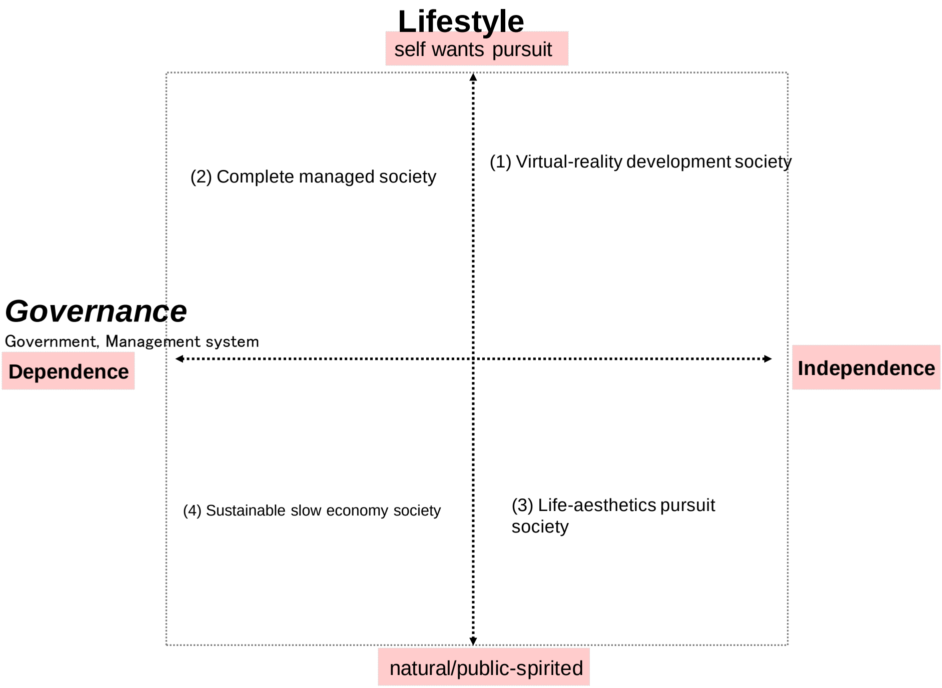

Fig.5 Four future ICT Societies

3) Issues regarding the depiction of future desired-society

While sketching these four scenarios, two important issues were discovered.

First: how can a "desired-society" be clearly defined? Second: how can one ideal future-desired society be selected from the four above scenarios. With reference to the first issue, a definition of a 'desired society' can be reached by looking at the 'technological approach' described above (Fig.3) and attempting to solve the basic problems this approach broached i.e. the possible negative impact of ICT on the mental/emotional condition of citizens and its indirect impact on the environment due to the acceleration of a 'Facile Lifestyle' and 'Loss of Authentic Human Contact.' To depict a cohesive, desired sustainable society it is necessary to create an approach whereby an increase in social consciousness gives rise to environmental consciousness which is also integrated with fundamental human values. This is a definition of a desired-society. As suggested it is necessary for advanced ICT to be utilized in such a way that promotes an emotionally healthy life-style. The approach to achieve this is the 'Techno-ontological approach' (Fig. 6).

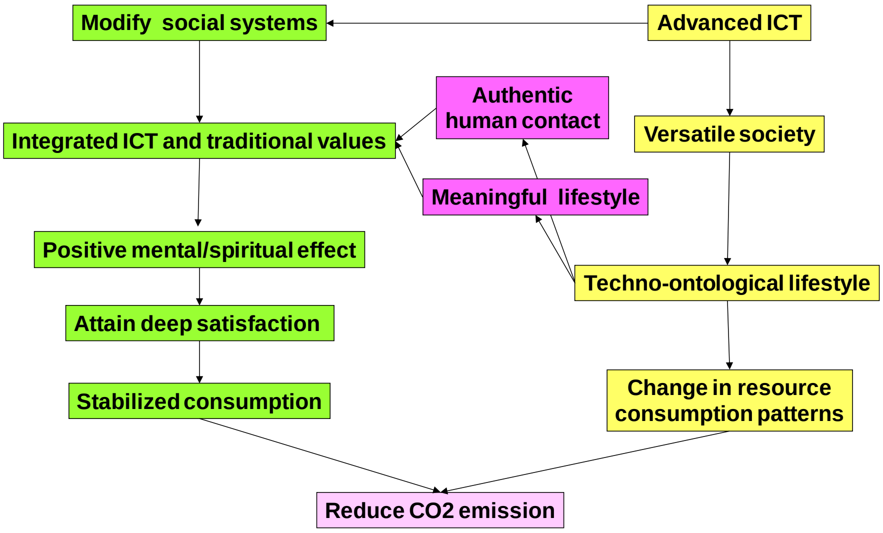

Fig. 6 Desired Model-Techno-ontological approach to ICT-

The Techno-ontological approach takes into account the issues raised in the ‘Technological’ approach, and considers how a fusion of ICT with mental/emotional and social conditions can help realize a truly sustainable low carbon society.

Utilizing ICT according to the ‘Techno-ontological’ approach has the potential to radically modify pre-existing social structures and help create a society in which advanced ICT and the traditional values of family, community and spirituality can be integrated. For example, it has already been suggested that face to face contact is necessary to authentically connect with people. In a techno-ontological lifestyle advanced ICT can help create opportunities for more authentic human contact by using *advanced* holographic and audio technology. Even if family and friends are separated by great distances, they can still ‘exist’ virtually in the same space. Having a versatile lifestyle means that people can have the freedom to find a more meaningful way of life. A husband or wife can follow their dream and work in a foreign country and yet still be in the same room as his or her family for dinner via advanced internet technology, thus maintaining traditional family values. By promoting a ‘techno-ontological’ lifestyle, where mental/emotional concerns are promoted through positive applications of advanced ICT, it may also be possible to stimulate the market for ICT products, thus having a positive impact on the economy.

The second issue is how to select the ideal future-desired society from the four scenarios. It has been clarified in the scenario-planning method, that a whole "desirable society" cannot be fully expressed by one quadrant. A desirable quadrant differs according to individual life-related elements, i.e. amusement and leisure, dwellings, work, education, food, etc. Therefore the position considered to be "desirable" for an individual life element must be defined on the basis of the ‘techno-ontological’ approach’ and brainstorming. One desired society can then be depicted by integrating these fragmented life elements .

(4) Scenario of a future-Desired ICT Society

The future desired society based on the above methodology is presented in seven daily-life scenes of the ‘Igarashi family’ in 2050. This imaginary family is made up of four members. The husband and son live in a rural area. The wife and daughter live separately. The daughter lives in a dormitory in the ‘City’ and thewife lives in a condominium in the ‘Big-city’. Seven life scenes which integrate advanced ICT with emotionally healthy life-style are depicted below:

1) Family is together even when separated

In modern cities such as Tokyo, it has become increasingly common for family members to eat meals separately. The phenomenon even has a Japanese name- ‘kagikko’, translated literally as ‘key children’. It refers to the growing number of children who, after finishing school, go home to an empty house because their parents are working late. The traditional notion of a family eating together is rapidly becoming obsolete. According to the Techno-ontological approach, the possible negative social/emotional implications of such a situation must be considered when utilizing ICT in the home. For example, by utilizing *advanced* ICT, the meal-time scene of the Igarashi family can be depicted quite differently. Whereas mobile phone and e-mails provide limited levels of communication between family members, a ‘virtual-door’ system enables more authentic and richer communication, even when separation is necessary due to business trips. The family can share everyday life experiences as if they actually live together. ‘Living together’ via virtual UI (user interface) and *advanced* information systems can lead to a more pleasant and emotionally richer family lifestyle.

2) Utilizing ICT in business-(agricultural)

Physical labor and long hours are diminished in the agricultural business scene of 2050. A robot through artificial intelligence supports secretarial functions, analysis functions, and heavy labor thereby reducing the amount of ‘routine’ work and giving workers time to regain their ’humanity’ and sense of self by thinking, imagining and feeling in a work environment. Companies and ventures can produce advanced technical development and services (high addition value) according to various needs. Due to the network of information, business dialogue and information gathering can be carried out anywhere. Mr. Igarashi turns over the soil using a robot-type machine and also gets business information through the internet. His son helps him plant crops and observes unusual insects using an ICT magnifying glass. This can lead to a versatile work style increasing feelings of satisfaction and allowing the worker to consider things from family responsibilities to agricultural products and the development and sale of new kinds of food.

3) Attending an International conference at SOHO in the ‘Big-city’

Women can pursue a meaningful life style, because advanced technologies allows them to care for children, do house work and maintain a career.

4) Shopping using ‘Eco-money’

People obtain “Eco-points” if they actively demonstrate environmental consciousness. Eco-points are recorded automatically using advanced ICT. Various goods can be bought using eco-point like “money”.

5) Celebrating the birthday of his son from anywhere in the world

Advanced translation systems make it possible to communicate with various foreign people.

Mr. Igarashi's son's friends in foreign countries say "Happy birthday!" through the 'virtual door system'.

6) Class observation day

Children can learn various social experiences using both actual and virtual measures in the lesson. Parents can make more free time for their children while they work. Many families attend the class observation day through the virtual system.

7) Virtual world travel

The Igarashi family travels to the Multi-event space to experience and make contact with various cultures and landscapes in the world. Advanced ICT can vividly recreate such an experience as if really existing before their eyes.

(5)CO_2 Reduction Effect of Future-Desired ICT Society

From the above social scenarios, how much it would be possible to reduce CO_2 was estimated by using the "Snap-shot" tool which was developed by another team in this project (Booklet by National Institute for Environmental Studies). This tool calculates the energy balance table and the CO_2 emission table immediately with keeping consistency among sectors (industrial, residential, commercial and transportation), when service demand, share of energy and energy improvement by classification of service and energy are entered in the base year and the target year.

The hypothetical changes in the 2050 scenario for energy consumption from daily-life origin were conducted. For example, the "Virtual door system" would increase electricity in home but reduce transportation energy. In this table, values of energy consumption increases or decreases were roughly estimated. Then by using the above tool, it would be possible to show the reduced value of CO_2 emission in 2050 scenario. It was clarified from our estimation that the CO_2 emission of household origin in the future-desired ICT society of 2050 would be 2,389 kg-C / household & year in the apartment type in the city, and 2,484 kg-C / household& year in a rural detached house. The result was shown that the CO_2 emission of household origin in the future-desired ICT society of 2050 can be potentially reduced by about 40 percent in comparison to Japan's total CO_2 emission in the year 2000.

Figure 7 summarizes ICT diffusion influence on Japan's total CO_2 emission. In 2050, our forecasting-estimation was about 10% reduction. On the contrary, the back casting estimation was over 20% (40% reduction in household origin). These results suggest that both drastic greenhouse gas reduction and a comfortable emotionally healthy lifestyle could be compatible.

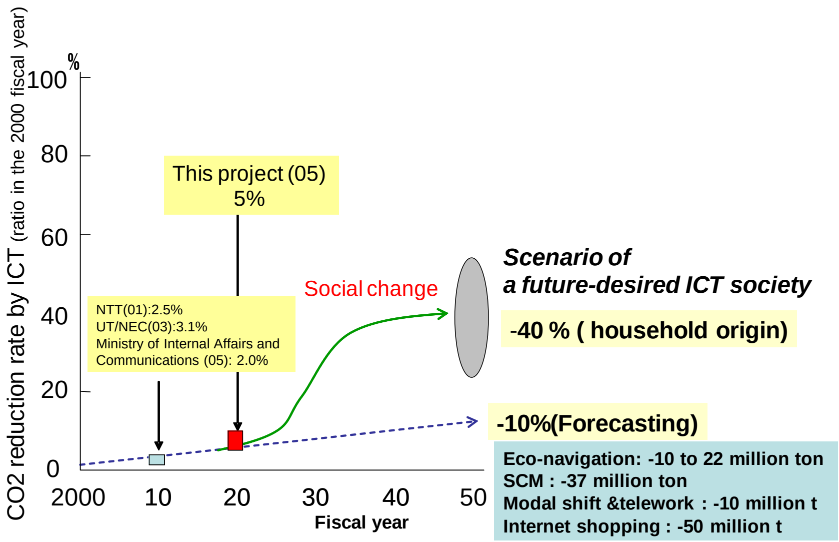

Fig.7 Environmental influence of ICT in the future

(6)ICT impact on economy

Regarding ICT impact on economy, we have to see the impact both in domestic viewpoint and in global one. In global one, the most significant issue is the phenomena of ‘Offshoring’. Generally, ‘Offshoring’ refers to the relocation of business processes, such as production, manufacturing, or services, from one country to another.

A long-term simulation model, which composed of macro-economic model, Input-Output tables and energy model, have been developed in order to calculate the economic and energy structure for Japan, USA, China, and India, up to 2050, including macro effect of offshoring caused by ICT revolution. In 2050 Japan, GDP was 737 trillion Japanese Yen (JY), and GNP was 830 trillion JY. This means about 100 trillion JY was acquired from overseas investment. The population of employment was reduced 34.4million in 2050 comparing with 51.6 million in 2000. Due to this industrial structure change, the total energy consumption in Japan reduced 13,376 Peta-Joule (PJ), from 15,982PJ in 2000. And ratio of industry sector reduced to 41% in 2050 from 47% in 2000.These results reveal that ICT impact on Industry in 2050 accelerate economic growth in service sector, which results in reducing energy consumption from industry in Japan. On the contrary, in global viewpoint, economy of individual country affects multilateral economic situation i.e. Offshoreing GDP transition up to 2050 in four countries. Chinese GDP may be larger than USA’s GDP in after 2010 and India’s GDP will become the similar values with USA’s GDP in 2050. The gross GDP in these countries shows radical increase during this period (2000-2050). The CO_2 emission of these countries also indicates radical increase from 2000 to 2050 according to GDP extension. All part of these changes doesn’t caused by ICT diffusion. However, ICT diffusion affects partly to this economic extension. Thereby, ICT impact on industrial structure, regarding CO_2 emission would lead to positive effect limitedly in Japan, but in global view that may be negative effect.

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