

“Future Challenges in the Photonics Market” -Target at the Green Digital Economy-

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Abstract

Photonics market statistics till last year (2008) in Japan provided by OITDA is shown in the field of display, optical memory, I/O equipment, fiber communication, laser processing, photovoltaic cell and sensor/measurement. It is predicted that the challengeable saving energy photonics products connected to the broadband system with the fiber communication are prospective to enhance the “Green Digital Economy”.

1. Introduction

As an introduction, I start with a very interesting and important data from Standards & Poors shown in Fig. 1. The vertical axis is the PER that is the stock market price divided by actual profit. It is said that when PER is around 10 the stock market is healthy. But when the stock price is much higher than the profit, bubbles are taking places. The highest peak can be identified as the ICT bubble and it's collapse. And in the past, we have experienced several bubbles which can be identified by the railway, broadcasting, automobile and consumer electronics. But we cannot imagine our contemporary civil life without these fundamental technologies as social infrastructures. And if you extrapolate this analogy to the ICT bubble, ICT will continuously spread widely and deeply into our social civil life in the future and support our civil economy.

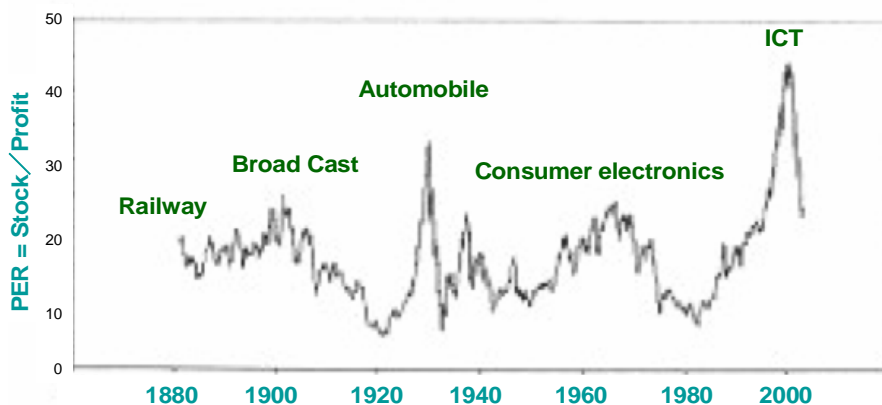


Fig. 1 History of bubble economy (Reference: Standards & Poors)

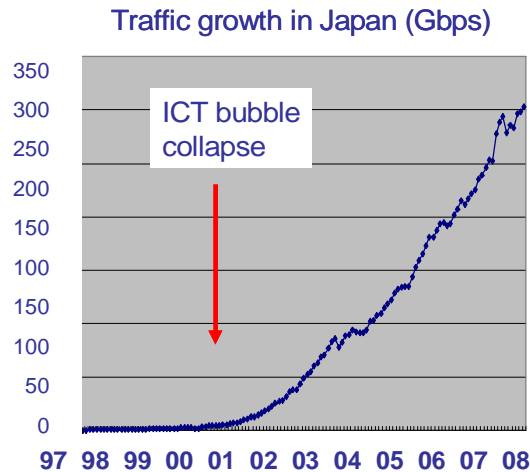


Fig. 2 Internet traffic growth in Japan
 (Source: MIC / Ministry of Internal Affairs and Communications)

Another important data taken by MIC is shown in Fig. 2. Just after the collapse of ICT bubble in 2000, the internet traffic is increasing with a ratio of about 40%. This data is one of the proofs that ICT is continuing to spread into our social life. And the economy that is driven by the ICT is called digital economy and photonics technologies are occupying parts of ICT and therefore, they will also grow with the growth of the digital economy hand to hand when they are connected to the digital network value chain.

2. Photonics market statistics

With this back ground, the photonics market statistics is discussed that has been taken by OITDA since 1980. OITDA is a member of IOA (International Optoelectronics Association / founded in 1996) that was established in 1980 by the Japanese electronics firms like Hitachi, Mitsubishi, Toshiba, NEC, Fujitsu, ...and now supported by 160 firms including Canon, Nikon, NTT and others. The international members of IOA is listed bellow and is indicating that the OITDA was founded firstly.

Table. 1 Member list of IOA

Area	Name	Foundation Date
Japan:	OITDA (Optoelectronic Industry and Technology Development Association)	1980. 7
USA:	OIDA (Optoelectronics Industry Development Association)	1991. 7
Taiwan:	PIDA (Photonics Industry and Technology Development Association)	1992. 8
UK:	SOA (Scottish Optoelectronics Association)	1994.10
Korea:	KAPID (Korea Association for Photonics Industry and Technology Development)	2000. 5
Singapore:	PAS (Photonics Association, Singapore)	2000. 7
Germany:	Op Tech-Net	2000.
Australia:	APF (Australian Photonics Forum)	2000
Hong Kong:	HKOEA (Hong Kong Optoelectronic Association)	2002
Europe:	EPIC (European Photonics Industry Consortium)	2003

Since 1980, OITDA continue to take the market research statistics every year using questionnaires to about 300 Japanese firms asking products of the last year, this year's estimation and the prospect of the next year. OITDA is organizing 7 committees from display to sensing/measurement those consist of about ten photonics specialists and totally about 70 specialists. And the results are analyzed and summarized by the analytical committee. And the estimated value of the year before last is replaced to the actual value every year.

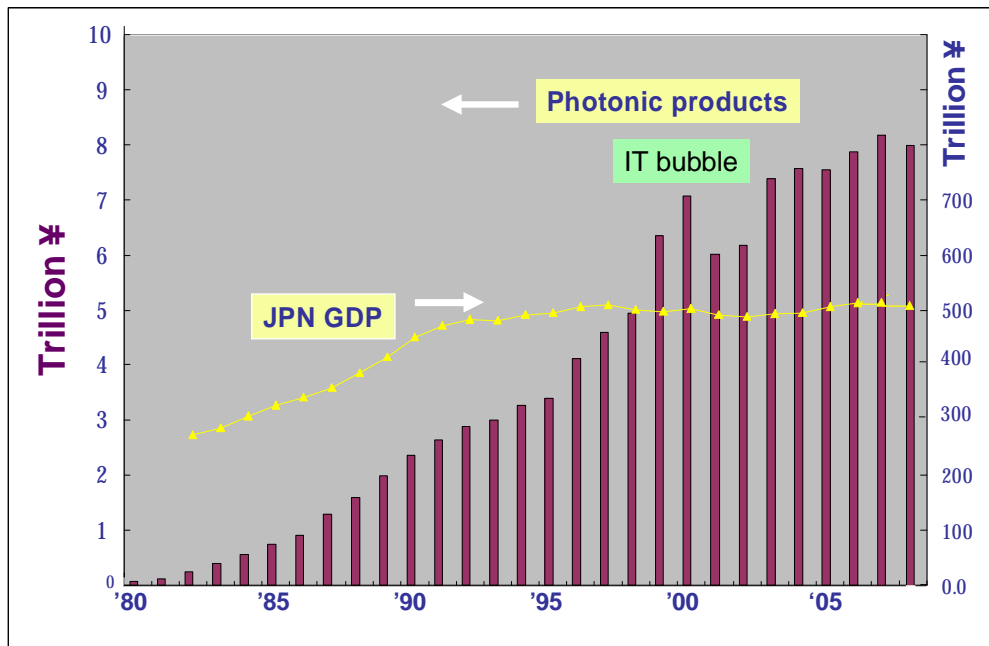
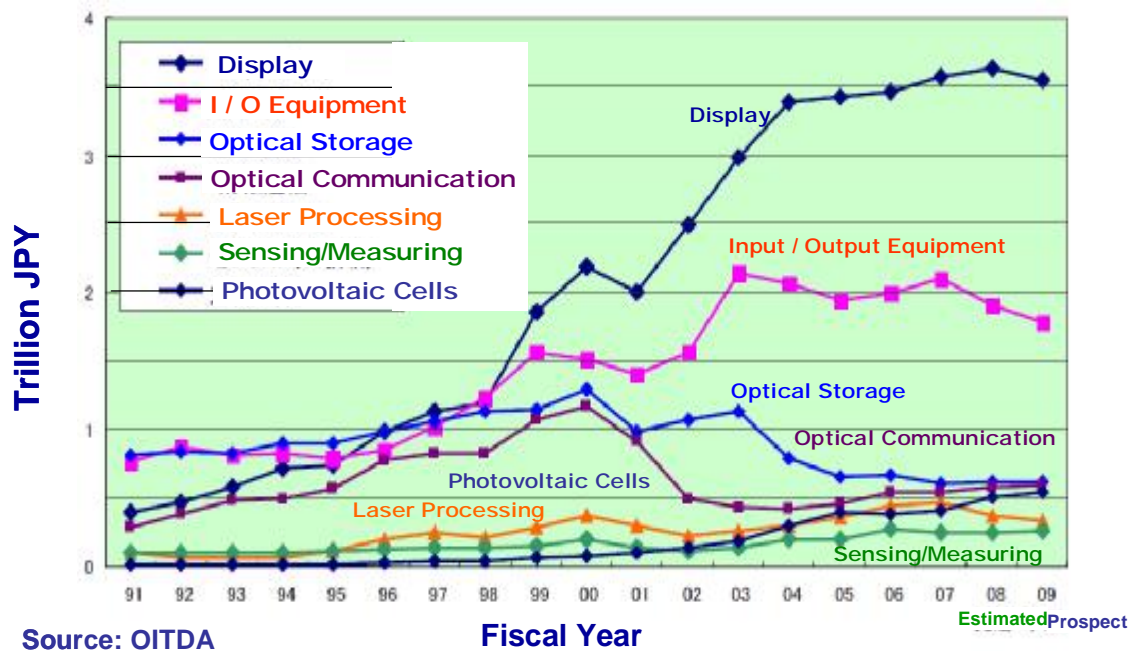


Fig. 4 Photonics market size annual trend (OITDA)

Fig. 4 is one of the results of the statistics showing an annual trend of photonics market in Japan. There is a dip in 2001 that can be identified as the ICT bubble and its collapse. But after the dip, the market is growing again and the growth rate is larger than the growth rate of the Japanese GDP (Gross Domestic Products). The total market size of the year before last (2007) was 8 trillion and 70 billion JP Yen that was 2.6% increase compared with 2006. It was due to the increase of the digital camera and the flat panel display. And in 2008, last year, it is estimated to be 7 trillion and 964 billion, that is 1.3 % decrease because of the world wide financial recession.

Then let me show you photonics market trend from field to field as shown in Fig. 5. The largest is the display, and the second is I/O equipment like digital camera and optical memory, optical fiber communication, laser processing, photovoltaic cell and the sensing/measurement products.



Source: OITDA

Fig. 5 Annual product trend by field (OITDA)

Then let me go to the detail more. Regarding the display market in 2007, the market increased with a ratio of 3.5% mainly due to the high-value added larger size LCD display of more than 40 inches. And in 2008, larger growth had been expected due to the Beijing Olympic game but estimated to be 1.6% because of the price reduction and the world wide economical down turn.

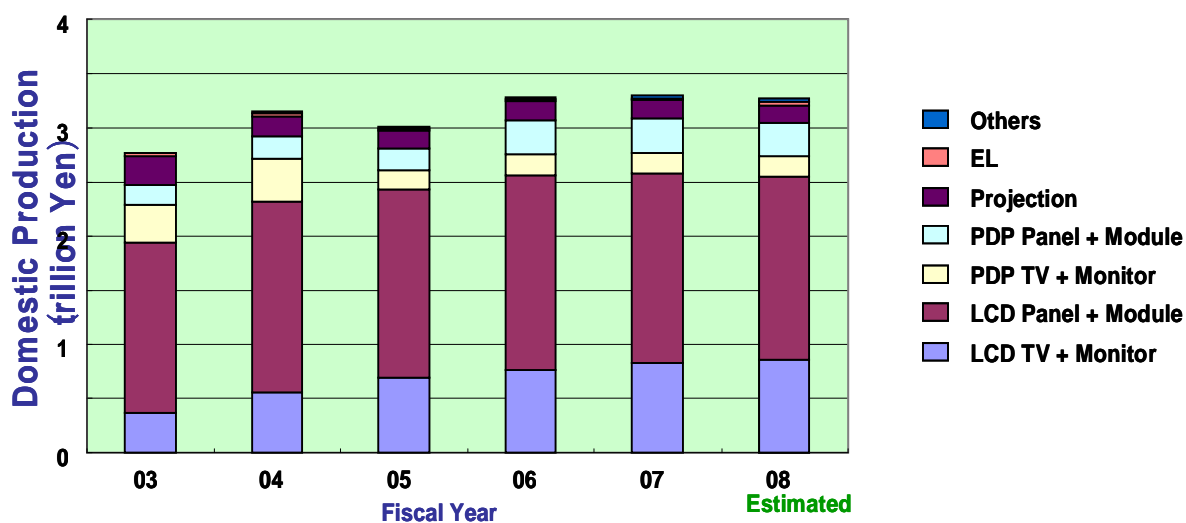


Fig. 6 Annual product trend of Display (OITDA)

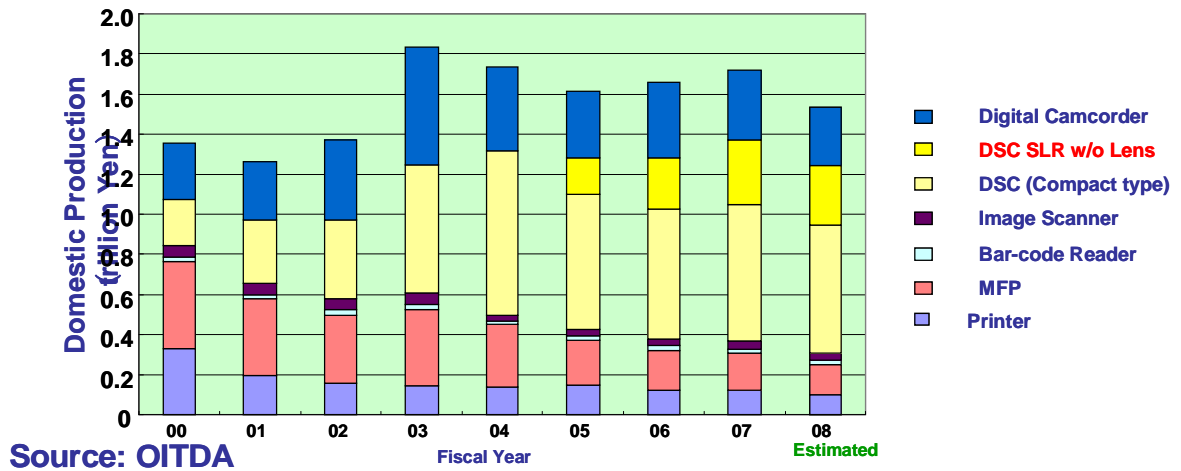


Fig. 7 Annual product trend of I/O Equipment (OITDA)

For the Input output equipment, the growth rate was 4.1% in 2007 due to the remarkable growth of SLR (Single Lens Reflex) type digital camera. But in 2008 last year, the off shoring of the manufacturing and the price reduction were accelerated especially in the conventional low end production. And hence the firms are estimating that the market will be reduced down with the ratio of minus 11%.

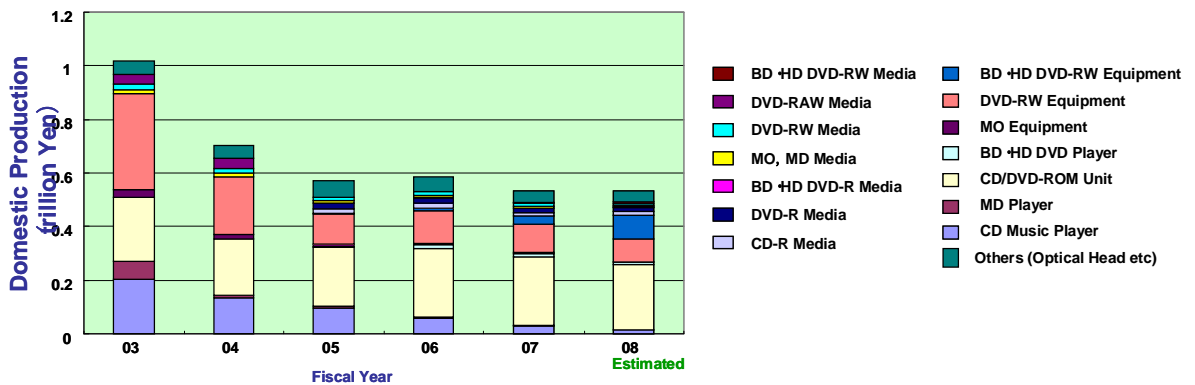


Fig. 8 Annual product trend of optical storage (OITDA)

Regarding the optical storage mainly optical disk market in Japan in 2007, the product was reduced down with 6.4% including player and media. It is because of the stronger competitiveness of the higher density magnetic hard disk and IC memories. But in 2008, it is estimated that the growth rate of 3% expecting the market growth of Blu-ray disk.

For the optical fiber communication as shown in Fig. 9, the product has been increased because of the deployment of the FTTH system in Japan. And the number of subscribers

in Japan increased up to 14 million in 2008. And in 2007, optical fiber amplifier was increased about double due to the application for the submarine fiber communication. And in 2008, 6.8 % growth is estimated because the FTTH subscribers are going to be ready to the termination of analog TV broadcasting and the convergence of the broad casting and the telecommunication to be in service.

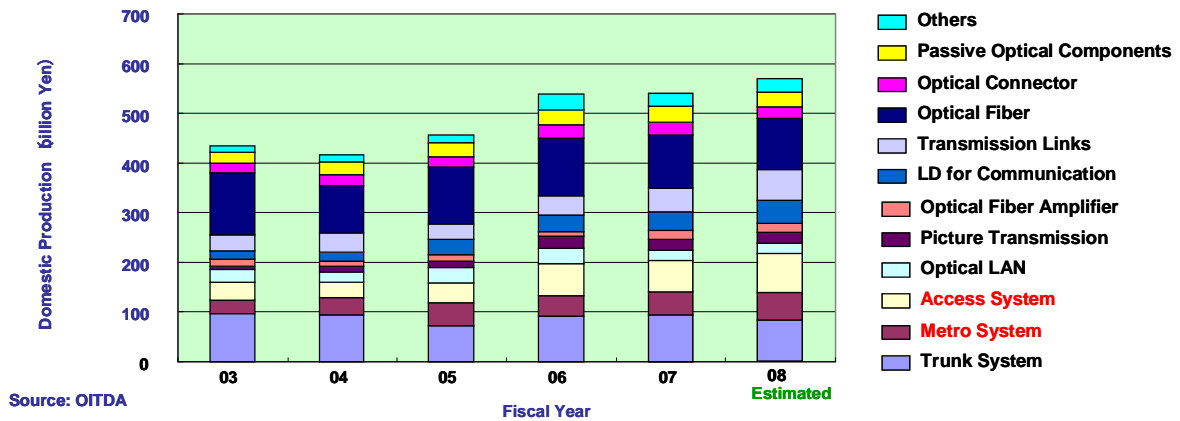


Fig. 9 Annual product trend of Optical communication (OITDA)

For the laser manufacturing and processing production field in 2007, it was increased up to 7.2% including laser sources. The market driving production was the excimer laser stepper for the semiconductor manufacturing. But in 2008, 22% reduction is estimated because of the semiconductor business recession as a main reason. And the decrease took place not only in the excimer laser but also CO₂ laser and solid state laser equipments.

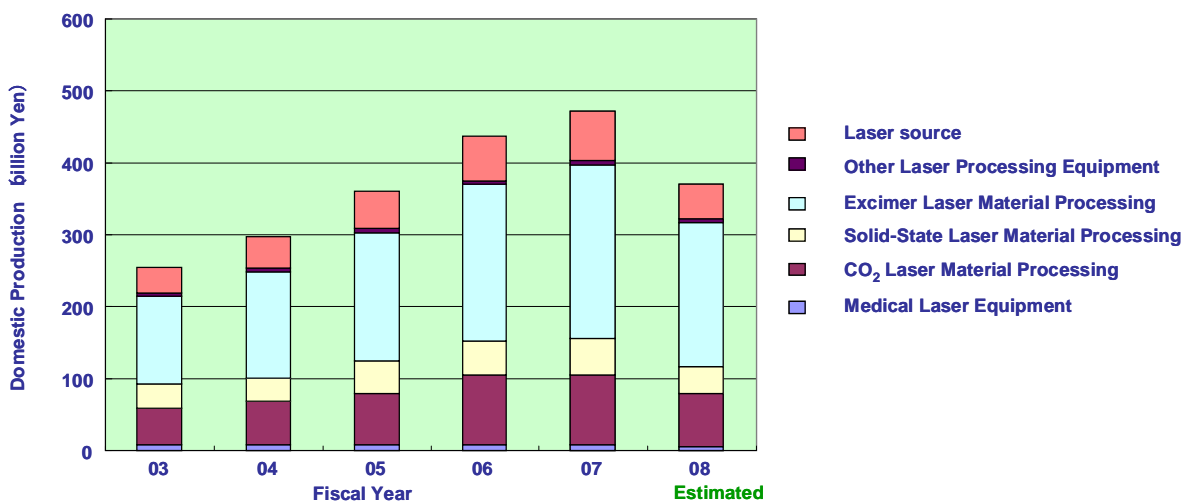


Fig. 10 Annual market trend of Laser processing (OITDA)

Fig 11 is showing Sensing/Measurement field. During these few years, industrial investment from the aspect of security has been the reason of the market growth in this field. But in 2007, the market was reduced about 10% because of the saturation of the investment. And in 2008, 3.6% increase is estimated because of the enforcement of the fire related new law in Japan.

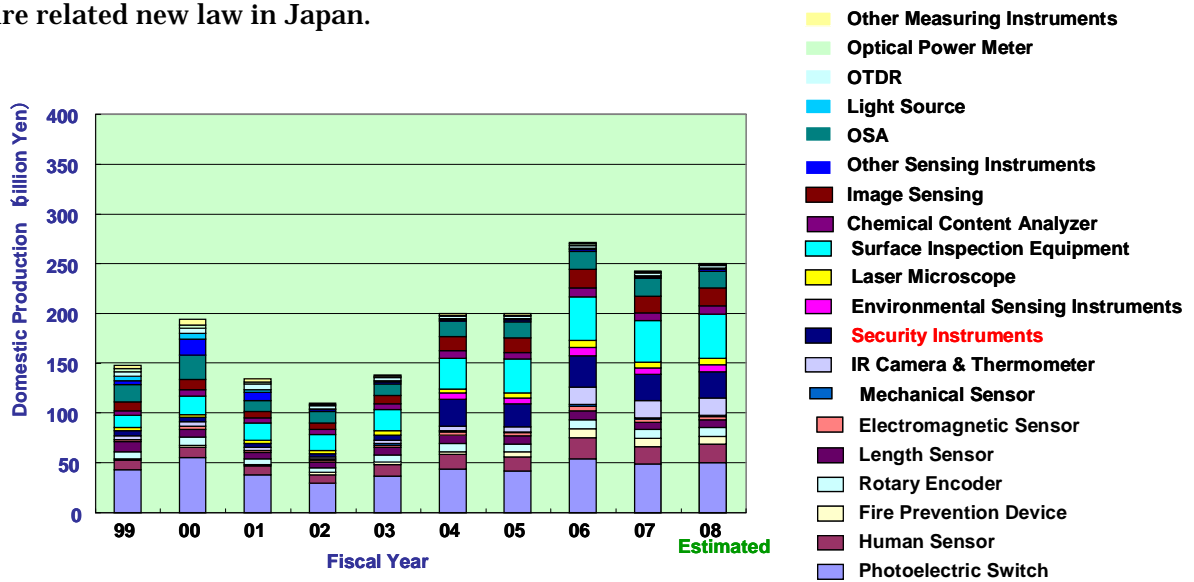


Fig. 11 Annual product trend of Sensing/Measurement (OITDA)

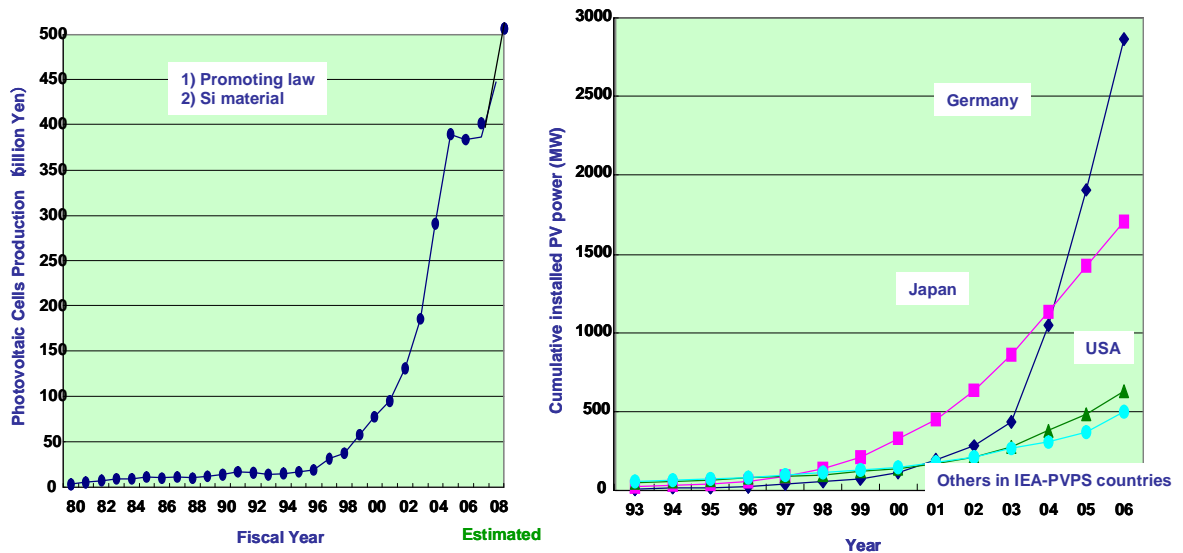


Fig. 12 Annual product trend of PV cell and the world production share (OITDA)

And in the Photovoltaic solar cell market, special attention should be taken. As you can see in the Fig. 12, something happened in 2005. There are two reasons for this dip.

One of them is the termination of photovoltaic cell promotion law in Japan in 2005 and another is the shortage of silicon material supply in the global market. But in 2007, the law was revised and the silicon market supply increased due to the strong demand from the European market as indicated by the right data of Fig. 12. It is also showing that a strong competition between Europe, Japan and USA is triggered to start.

3. Decade forecast

Up to now it was shown what happened in the Japanese photonics market in the past till last year. But in this section, a decade forecast which has been done by the OITDA in 2004 is explained. The decade forecast was a world wide market prediction that has been done by the 7 committees organized by OITDA. The result is shown in Fig. 13 and the making process of the result is as follows.

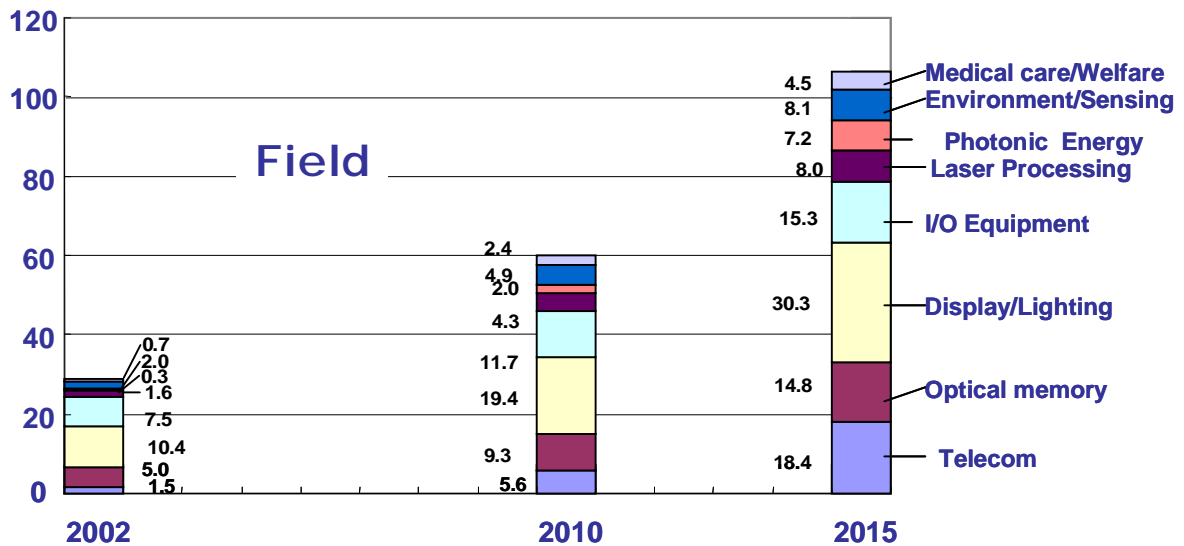


Fig. 13 World wide photonics market prediction (OITDA)

In the first step, the committee discussed the future image of the social life vision and summarized into three key features. They were 1) Less birth rate & longer life, 2) Sustainability, and 3) Borderless economy.

And in the second step, the committee made a correlation table between these three key features and the future photonic products for the three user categories as the consumer, industry and government. Regarding the Less birth rate & longer life aspect, one of the messages that the committee has observed was that the life style change would take place for the consumer in the field of medical care, satellite office and home office for example. And to realize such a life style, the improvement of ICT, memory, display, I/O equipment photonic products will be strongly required.

For the sustainability in the industry for example, more service oriented products will be required than material or energy oriented products. And hence ICT, I/O equipments, highly efficient energy technology, environmental sensing will become more important.

And in the future borderless society, ICT will be more important for every user as Tom Friedman is telling us in his book titled "The world is flat". Being based on these qualitative discussion, the committee convinced that the photonic products market will surely increase in these 10 years.

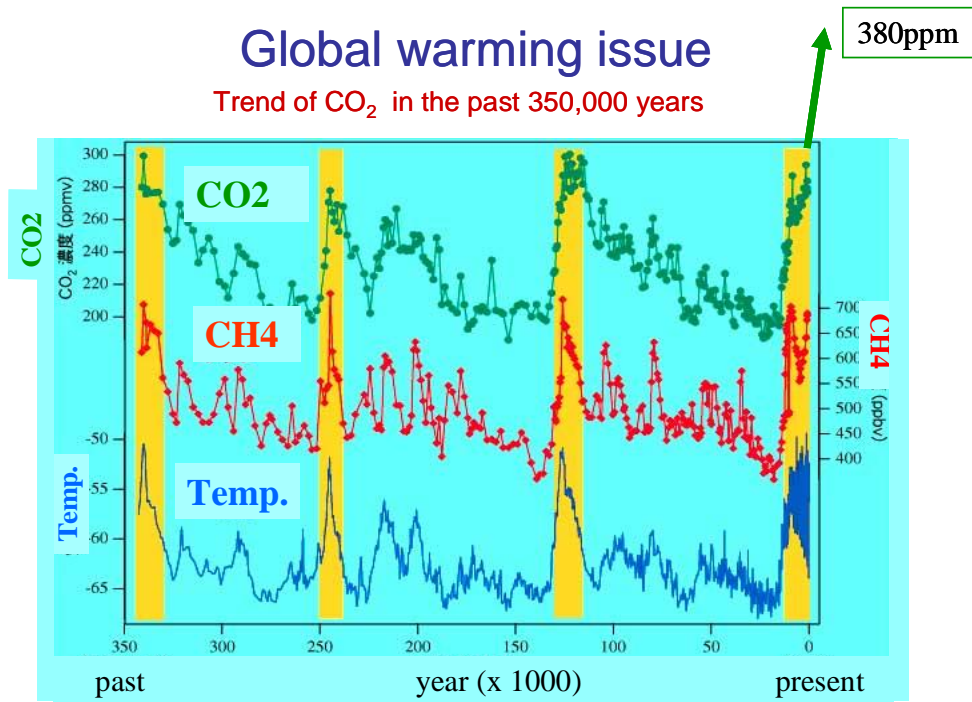
And in the third step, the committee tried to make more specific and quantitative decade forecast. To do the prediction, the market size is divided into two parts as conventional products and the future products. For example, in the field of display, plasma and liquid crystal flat panel display are conventional but in the future, organic flat panel display will be commercialized. And for the lighting, not only LED but also more efficient OLED is expected in the future.

And for the quantitative prediction, the decade forecast working group used many kinds of official statistics opened in the public domain. The data of population, GDP, trade are introduced not only from the Japanese ministries and think-tanks but also OECD, world bank etc. Fig. 13 is the final result of the world wide decade market forecast totally added by the each field of photonics productions world wide. In 2015, the market will grow up to about 4 times as much as in 2002 and the growing ratio of photonic-energy, solid-lighting and medical-care are larger than the others.

4. Green IT policy in Japan

The global warming issue is not a problem only for the Japanese but also for all over the world. Fig 14 is showing a relationship between the cycle of the temperature change of the earth and the change of CO₂ gas density on the earth. These data were taken from the ice core from layer to layer since 350 thousands year ago on the south pole continent. According to the announcement of the CAOS project, the CO₂ gas density was measured using small gas bubbles sampled from the old layers those correspond to from year to year. On the other hand, the temperature of each ice core layer were measured independently by the ratio between Hydrogen and Deuterium isotope.

The periodicity of these two cycles agree to be about 120 thousand year and acceleration can be observed due to the recent irregular CO₂ gas increase. And recently, the CO₂ gas density was measured up to 380 ppm that is much higher than the average peak value of 280 ppm that the earth has experienced. So the CO₂ reduction is becoming a very serious issue as you are already aware.



Source: Ice core analysis data at Antarctica (Tohoku University, CAOS)

Fig. 14 Temperature and CO₂ gas density change on the earth

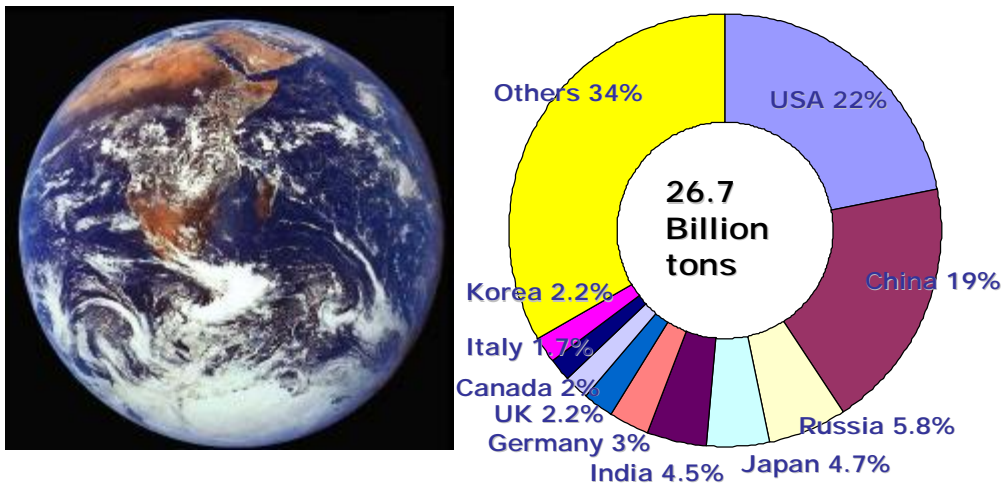


Fig. 15 World wide CO₂ emission share (IEA)

Fig. 15 is showing CO₂ emission share from country to country. There are many guilty countries in the world. The green summit was held at Toyako lake in Japan 2008 and the Japanese government proposed that the 50% reduction of CO₂ should be accomplished until 2050. And the summit convinced that the harmony between the

economical and social activities and the protection of earth's environment will be essential for the sustainable people's life.

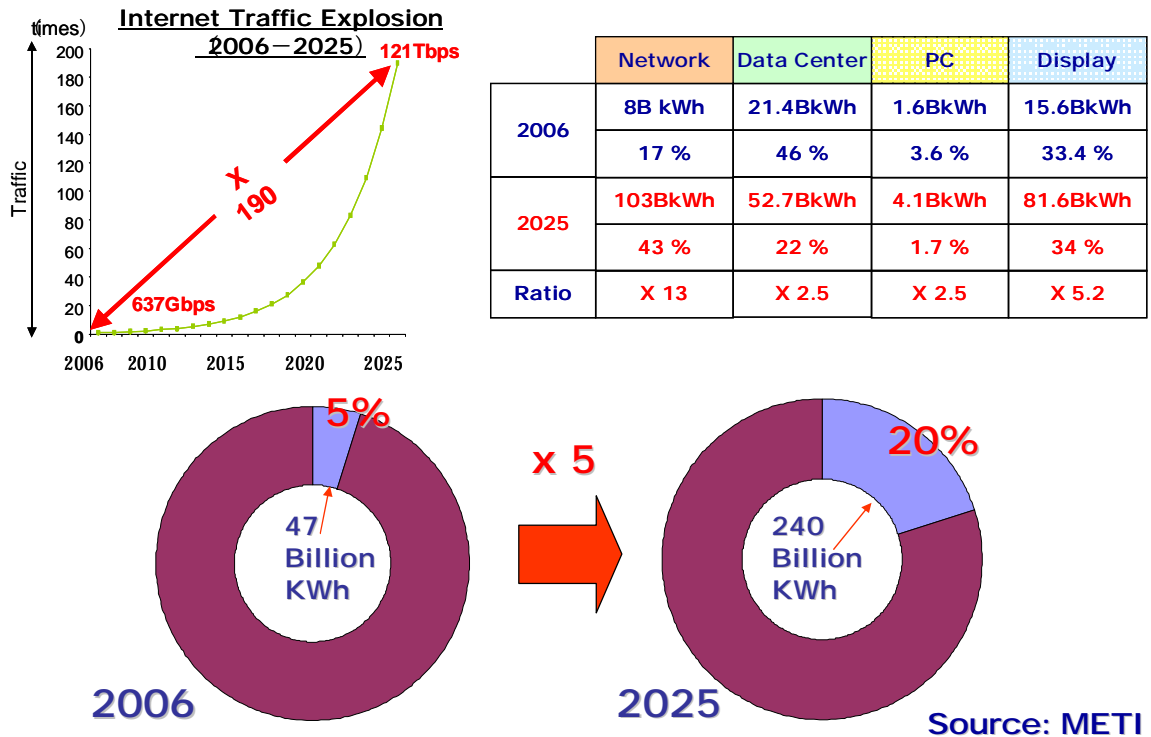


Fig. 16 Drastic increase of energy consumption in the ICT field

Fig. 16 is showing an estimation of information explosion and accompanied energy consumption growth from 2006 to 2025. The internet traffic would increase from 637 Gbps to 121 Tbps with the ratio of 190 times during this time interval. The table above is showing the increase of energy consumption by the ICT products from network, data center, PC and display. Therefore the development of energy saving technologies will be very important in the ICT technical field.

Being stimulated by this serious data, Japanese government is promoting a policy and selecting 21 Earth cooling technologies in the categories of industry, transportation, office, home, and others as shown in Fig. 17. And in these fields, photonics technologies are included like photovoltaic power generation, intelligent transport systems (ITS), B.B fiber networks, next generation high-efficiency lighting and high-efficiency information devices with systems.

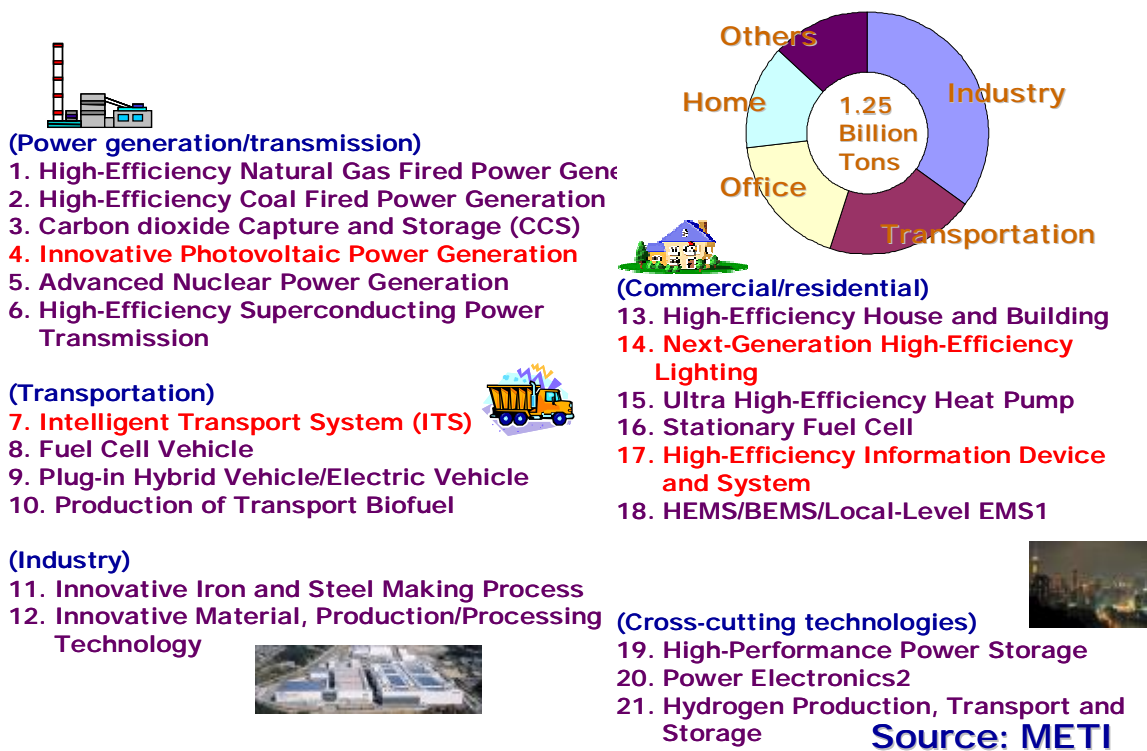
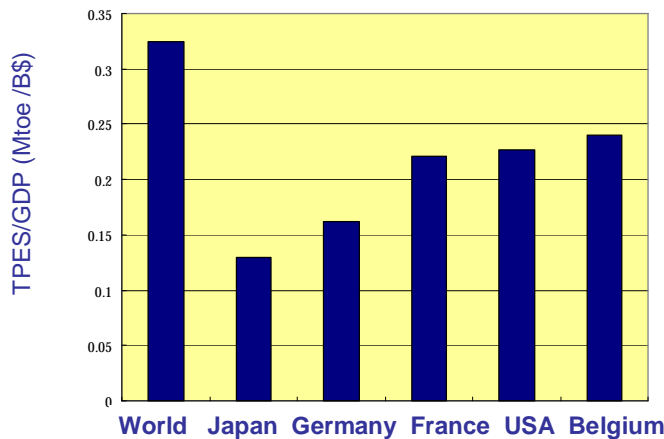


Fig. 17 21 Earth cooling technologies promoted by the Japanese government

5. Future Challenges

Finally, the future challenges in the photonics market is discussed before listing the specific products. Fig. 18 is showing a comparison of the energy efficiency of the economy from country to country.



TPES: Total Primary Energy Supply
Mtoe: Mega tones Oil Equivalent

Source: IEA (2006)

Fig. 18 International Comparison of the energy efficiency of the economy

The vertical axis defines TPES (Total Primary Energy Supply) with the unit of MTOE (Mega tones oil equivalent) divided by GDP in billion dollar. The data is from IEA (International Energy Agency) in 2006. The Japanese production energy efficiency is one third of the world average and obviously Japan is the most efficient country in the world and the Japanese energy saving technologies are advantageous in the world competitiveness. Therefore the Japanese firms are going continuously to enhance this advantage of the highly efficient technologies and products in the future.

Table 2 Future challenges in the photonics market

Field	Technology	Firms
·Display	OLED	Sony: 11'(on sales), 27'(proto) (Chimei: 25', Samsung: 40')
Lighting	LED, OLED	Panasonic, Citizen, Nichia, IDEC etc (Taiwan, Korea)
·Photovoltaic cell	Thin film Si, Compound	Sharp, Sanyo, Kyosera etc.
·Measuring / Sensing ·I/O equipment	Automobile Robot Buildings	Research: Toyota, Honda etc.
·Fiber communication	FTTH	NTT, KDDI

Future challenges in the photonics market are listed in table 2. The first is the application of OLED (Organic Light Emitting Diode) to the ultra thin flat panel display. Sony has launched 11 inches panel in 2007 and is demonstrating 27 inches prototype. The demonstration from Chimei Taiwan of 25 inches and Samsung of 40 inches are telling that a strong battle field is taking place in the east Asia. Another battle field is in the field of lighting. Not only LED but also OLED is becoming a prospective competitor.

And in the fiber communication field, Japan is leading the installation of FTTH systems as a statistics of the number of the FTTH subscribers is indicating as shown in Fig. 20. Even after the ICT bubble and it's collapse, NTT and KDDI continue to invest and deploy the FTTH system strongly, and the number of subscriber in Japan caught up that of metallic ADSL. The bit rate of the FTTH is up to 100Mbps and it looks like the bullet train railway system“ Shinkansen” for the exploding internet traffic.

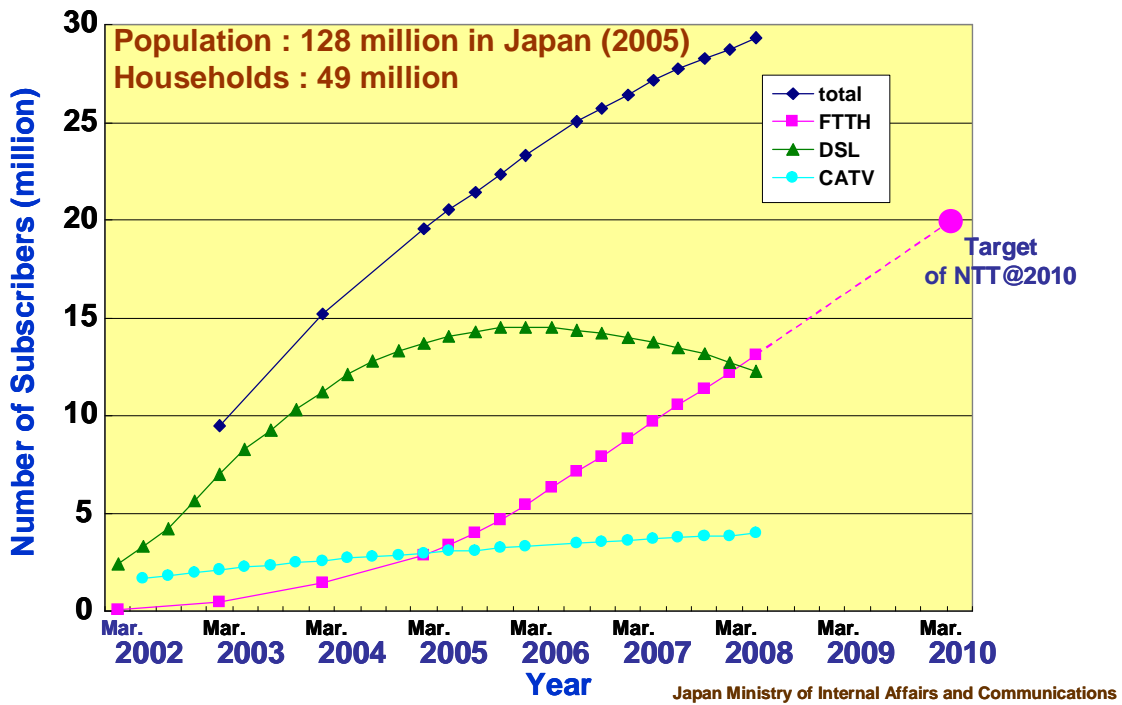


Fig. 20 Number of broadband subscribers in Japan (MIC)

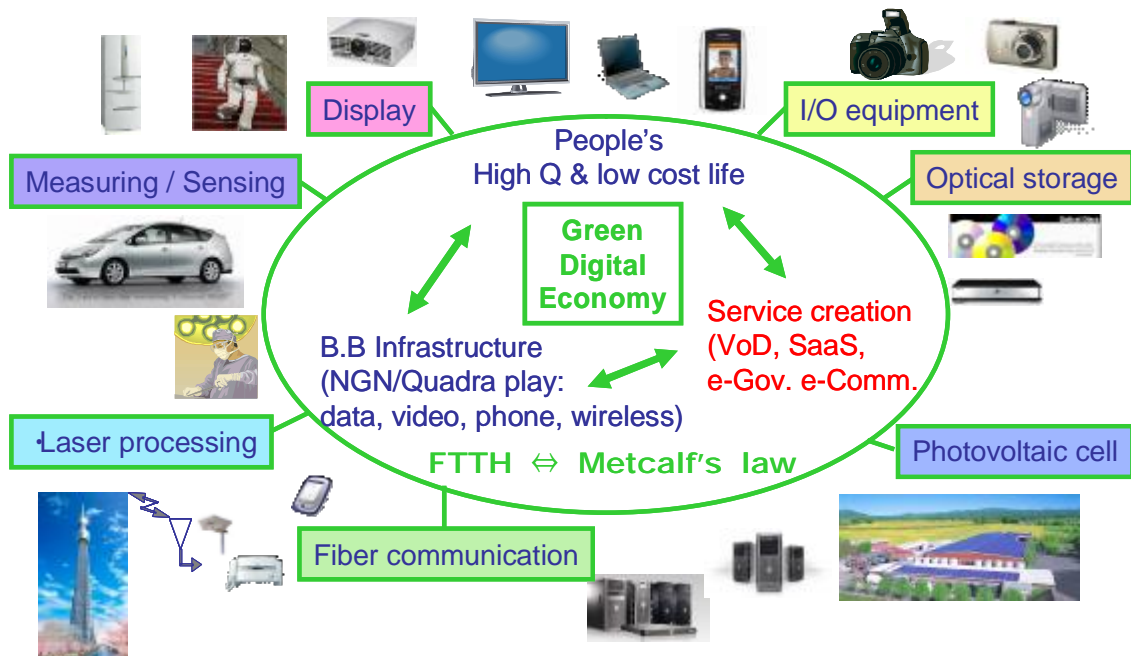


Fig.21 Future Challenges in the Photonics Market in the value chain
 -Target at the “Green Digital Economy” connected to the broadband fiber network-

The economical effect increases with a square of the number of the subscriber and the number of digital staff those of connected to the net work value chain, according to the Metcalf's law. And recently, as mentioned previously, new digital staff called clean energy generating PV cell is going to be connected to the net work with the delivering controlling system using monitor sensors. The conventional energy generating systems would be also connected to the broadband network to minimize the total energy consumption.

The consumer requires higher quality and lower price services from the service provider and the service provider requires broader band to the hardware manufacturer for the infrastructure. And hence these three positive feed backs will enhance the new economical impact that is called "Green Digital Economy" as shown in Fig. 21.

6. Galapagos problem

But regarding the Japanese firms, they are facing a serious problem that is called Galapagos problem. Japanese economist is analyzing that there are two types of total manufacturing process as shown in the table 3. One is called vertical integration type that Japanese firms are applying. It means every manufacturing processes are managed by one big firm by itself using its subsidiary companies. Because the big Japanese manufactures are thinking that value added is generated from the integrated fitting and adjusting technologies in the interfaces between each manufacturing process especially for the Japanese consumer market of hundred millions. As a result, the Japanese made products evolved to be an extremely sophisticated style like mobile phone for example, so to say, high-end and nitche type products. In the case of Japanese automobile and digital camera, they are still successful because they are stand alone type products and not connected to the communication systems. But the products those connected to the communication network and broadcasting systems like mobile phone, PC, LCD, Japanese firms are loosing their international market share.

On the other hand, rest of Japanese firms, they are operating horizontal division of labor type manufacturing processes that is called "Modular" type. For example, they are dividing their manufacturing process into modules like design, component, assembling and the brand. The interfaces between the modules are standardized in simple manners. Therefore it is easier for the new companies to join in to the active and growing middle-low-end, volume zone market and hence the price goes down as Adam Smith has analyzed and promoted in his "An inquiry into the nature and causes of the wealth of the nations". But this type of manufacturing has disadvantage in the automobile and digital camera because they are consist of mechanics, electronics, optics and thermo

dynamics which require many fitting and adjusting technologies in the total manufacturing integration process.

Table 3 Comparison of the manufacturing type: Advantage and disadvantage

Type		Manufacturing Process	Market	Products
Japan (Galapagos?)	Vertical Integration		High-end Niche	Automobile, Digital camera, Mobile phone, PC, LCD....
Universal	Horizontal division of Labour: Modular		Middle-low-end: Volume zone	Mobile phone, PC, LCD...., Automobile, Digital camera

7. Conclusions

In conclusion, photonic product market statistics mainly in Japan up to the last year (2008) and world wide decade forecast in 2004 provided by OITDA have been introduced and analyzed. The history of the bubble economy is telling that the fundamental technological innovation like broadcasting, railway and automobile generated bubbles in the past but they deployed and widely spread into our daily life and giving essential contributions to the base of the contemporary modern economy. The ICT that has generated the steep bubble in 2001 can be regarded as the newest fundamental innovation. And in Japan, the photonic products are parts of the ICT and hence it is increasing with higher growth rate than the Japanese GDP even after the ICT bubble and it's collapse.

To predict the future photonics market, the global warming issue is a serious problem for the sustainability. But it can be regarded that it will give more chances for the growth of photonic products due to the lower energy consumption. In the future, for example, energy saving OLED applied to the flat panel display and solid state lighting will be important and photovoltaic cell as a clean energy generator will keep growing and the growth will be accelerated when they are connected to the broadband network supported by the fiber communication value chain. The Galapagos problem that Japanese firms are facing will be solved again by the "Fitting & adjusting integration technologies in the processes at each interfaces. The future challenges in the photonics market is targeted at the "Green Digital Economy".

(Presented at "Photonics 21", Brussels, Dec. 9. 2008)

Reference

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