



**What is Product-Service Systems (PSS)?**  
**- A Review on PSS Researches and Relevant Policies -**



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## What is Product-Service Systems (PSS)? - A Review on PSS Researches and Relevant Policies -

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### ABSTRACT

In order to achieve sustainable society, it is necessary to transform industrial structure to the one that does not reduce the Earth's resources. Under this circumstance, a business model of "not selling goods, but selling services" has been expected as a measure of co-existence of business and the environment. This idea, which is called as "Product-Service Systems: PSS" or "Servicizing" etc., has been studied in Europe, the United States and international organisations, and is now studied in Japan.

However, the idea of PSS is still not effectively used for policy development. One of the major reasons is that PSS concept itself is under-developed. Under the unclear concept of PSS, researchers are working towards more scientific understanding while policy makers are trying to develop new policy measures, and there is confusion in those communities. In order to develop policy measures, it is necessary to make clear the position of PSS in socio-economic system. This paper overviews previous PSS researches and relevant policy measures conducted in Japan, the US and EU, and tries to grasp the context of researches and policy activities and to find out the agenda of the current status. The characteristics of PSS rest on the innovative relationship between producer and consumer. However, PSS researches are stuck at measurement of environmental loads, and relevant policies tend to be rest on the ones targeting producers. In order to get out of this situation, it is necessary to ask question what is PSS and to make it clear where PSS can be positioned in socio-economic system. PSS is important, because PSS has an element of creating sufficiency as well as eco-efficiency. It is recommended that PSS concept needs to be examined as a research effort, and environmentally sound product policy needs to be systematically organised.

**Keywords:** *Product-Service Systems (PSS), Servicizing, Dematerialisation, Extended Producer Responsibility (EPR), Integrated Product Policy (IPP)*

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## **1. Introduction**

There is a wide spread consensus that present socio-economic system of mass production, mass consumption and mass disposal needs to be transformed structurally in order to achieve sustainable society. Then, to which way does the system to be transformed? It is important that end-of-use products are returned to production stages, and material loop is closed: a transformation from a throw away type to a circular type. However, circulation accompanies environmental loads. Even though there is no loss of material in the circulation, it requires energy that cannot be seen by the eyes. Achievement of advanced use of material and energy is required as well as emission reduction of pollutants from manufacturing process and prevention of wastes. The perception that product itself is a potential source of pollution is being widely accepted.

In this circumstance, a business model change of "not selling goods<sup>3</sup>, but selling services" has received wide attentions. The logic seems to be that in a business model of "selling more goods and more profits", an incentive of selling more switches on, but in a business model of selling services, the incentive would not occur. However, the selling services still have a possibility that environmental loads would increase even though the amount of materials could be subsided. As a business model of "not selling goods, but selling services" prevails, the structure of material and energy flow would change, but that does not necessary mean it leads to the reduction of environmental loads.

Product-Service Systems (hereinafter "PSS") is a concept with a view of the structural transformation<sup>4</sup>, and has been evolved mainly in Europe. However, as it is introduced later, the definition is unclear and there are similar concepts<sup>5</sup>. Expectation towards PSS is big: European Union has conducted large-scale PSS research projects, and in the United States and Japan, PSS is being studied for policy developments. However, PSS researches have not effectively contributed to policymaking, and PSS researches and policy makers seem to be stalled with no way out. The major reason is that PSS researches have focused on PSS cases and have not enough examined where PSS is positioned in socio-economic system. Simple discussion like which PSS business model is good or bad would not contribute to policymaking. Without understanding PSS as a part of socio-economic system, it would not be possible to find effective policy.

This paper tries to answer what is PSS from the viewpoint of socio-economic system. Previous PSS researches have placed emphasis on "from goods to services", but comparison between goods and services would not bring any important meaning. Rather

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<sup>3</sup> In this paper, "goods" is used to express products in physical/tangible meaning.

<sup>4</sup> Other view of structural transformation includes social economy that is being activated with the emergence of social enterprise.

<sup>5</sup> Similar concepts of PSS include "servicizing", "eco-efficient service", and "sustainable service and system." This paper uses the term PSS representing these terms that has similar concepts. Each term is used when distinction is necessary.

than that, the emphasis needs to be placed on innovative relationship between producer and consumer, which is the characteristics of PSS. New relationships between producer and consumer are created in the changes of production styles and consumer's lifestyle along with the developments of information technologies etc. PSS researchers and relevant policy makers need to find out measures, which make these changes environmentally sound.

In order for PSS researchers and policy makers to get together and develop dematerialisation measures, it is inevitable to further examine what is PSS and where are the gaps. This paper, first, organises information on previous PSS researches and relevant policies. In Europe, researches have been conducted with regulatory policy in mind, and in the U.S. from the viewpoint of defending market initiatives. In Japan, PSS researches have just started, but a policy programme is already taken to promote green PSS business models. With understanding of these current situations, this paper proposes direction for future discussion on PSS concept: what is PSS. Since PSS re-examine the relationship between production and consumption, it has potential to lead the society from getting out of modern industrialism<sup>6</sup>. PSS concept will have a scope of post-modern<sup>7</sup>. By examining the potential, this paper is expected to contribute to PSS researchers and product policy makers.

## **2. Review of Previous PSS researches**

### **(1) Characteristics of PSS business model**

The concept of PSS has been developed with the emergence of some concrete business models in the market. What are the differences between PSS business models and traditional business models? Let's examine mechanisms of environmental load reduction by taking up the relationship between producer and its stakeholders, especially consumer or customer.

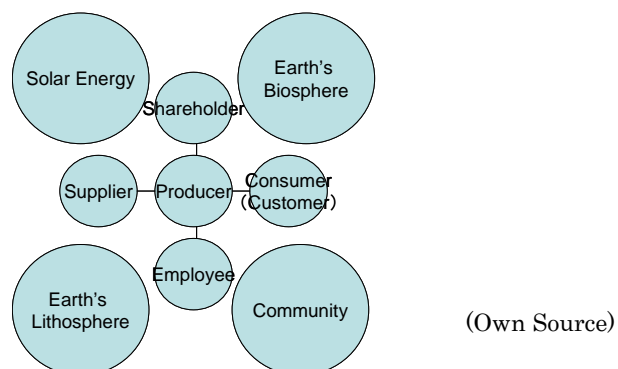
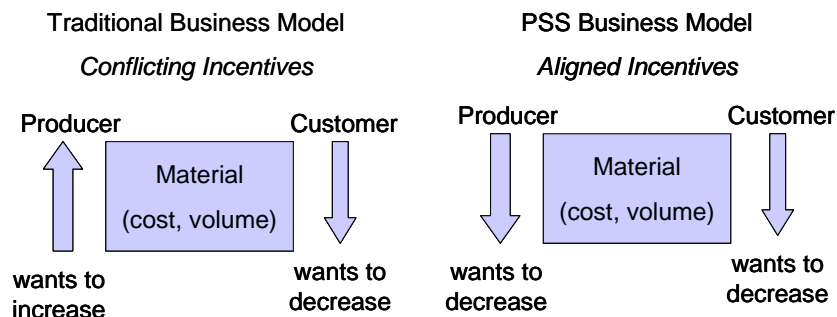


Fig.1 Stakeholders of producer

<sup>6</sup> Modern industrialism has such attributes as aggressive activism, rationalism that resort to any measure, and individualism. (M. Fukushi, 2001, Citizens and New Economics, (in Japanese))

<sup>7</sup> In this paper, the term post modern is used as a coming era that can have different attributes from those of modern industrialism.

In the PSS business model, the relationship between producer and stakeholder is recognised with a wide scope. As illustrated in Fig.1, it encompasses the whole product lifecycle and extends to community<sup>8</sup> and the environment: earth's lithosphere, earth's biosphere and solar energy. Then, it can contribute to the changes towards optimisation of the comprehensive system. In the traditional business model, producer has paid every effort to sell out goods. Without material circulation, the model forces raw material suppliers to exploit natural resources from the earth's lithosphere and sell it to producer. Used products are left in the environment and earth's resources are kept being reduced. Producer can be excluded from community as the relationship between producer and community is only on monetary terms. On the other hand, producer of PSS business model provide services to customer, which makes materials of the product go back to producer or supplier and reduces the amount of waste and usage of virgin materials. Furthermore, by increasing services via human resources, the producer can be included in the community, and can build an economy of scope rather than economy of scale.



Source: CMS Industry Report 2000

Fig. 2 Incentive structures between producer and customer

By further looking at the relationship between producer and customer, we can find that customer does not necessarily want goods depending on products. As for the products such as automobile, a sense of ownership contributes to his/her satisfaction. However, as for electricity, heat or coating materials, customer get satisfied when expected services or functions such as conditioned air or coated product are provided; customer does not stick to the amount of product or service. With this principle, business models such as Demand Side Management (hereinafter "DSM") or Chemical Management Services (hereinafter "CMS") can be effective. DSM is a measure that producer controls the demand of customer keeping customer's conditions out of

<sup>8</sup> Community provides producer with employees and receives wages from producer. This chart was developed referring to the Interface model, and community includes government.

inconveniences, and applied to energy provider or traffic service provider. CMS is a PSS business model, which does not sell out chemicals but provide lifecycle management services of chemicals. An interesting point of CMS is that both producer and customer have an incentive to reduce the amount of chemicals. As Fig.2 shows, in the traditional business model, incentives over material volume are conflicting between producer and customer: producer tries to increase the volume and customer to decrease it, but in the PSS business model, incentives are aligned. Aligned incentives do not automatically reduce the material volume, but the important thing is that certain innovative measures can be created with the incentives.

## **(2) Current status of PSS concept examination**

In order to obtain scientific knowledge on PSS, definition of PSS is indispensable. However, at present there exist various definitions. One is "a marketable set of products and services capable of jointly fulfilling a user's need."<sup>9</sup> The other defines PSS as "consisting of tangible products and intangible services designed and combined so that they jointly are capable of fulfilling specific customer needs."<sup>10</sup> These definitions seem to understand that the concepts of products and services are opposing each other, which has likely caused confusion among researchers and policy makers. In the world of marketing, a term "product" does not necessarily mean tangible object, but is broadly interpreted as tangible object, service, human resource, place, organisation, idea or a combination of these. So, it is not common to see product only as a tangible object. On the other hand, service is intangible. There is no doubt about it. However, providing service certainly accompanies tangible objects. Service cannot be designed independently from tangible object. Hence, it becomes clear that there are not substantial meanings on the two definitions. The term PSS seems to have been coined after the terms like "eco-efficient service", which seems to be more appropriate than PSS.

There is an example that defines PSS not just as a combination of product and service, but as a socio-economic system. A researcher defines PSS as "a system of products, services, supporting networks and infrastructure that is designed to be: competitive, satisfy customer needs and have a lower environmental impact than traditional business models."<sup>11</sup> To avoid understanding the relationship between product and service as an opposite one, it defines PSS as an element of socio-economic system including infrastructure, and restricts it to environmentally benign one. The environmental improvement of socio-economy has developed from product improvement

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<sup>9</sup> M. Goedkoop et al., 1999, Product Service Systems -Ecological and Economic Basics-

<sup>10</sup> A. Tukker, 2004, Eight Types of Product-Service System: Eight Ways to Sustainability? Experiences From SusProNet

<sup>11</sup> O. Mont, 2001, Introducing and developing a Product-Service System (PSS) concept in Sweden

stage to product re-design stage, but in order to achieve a significant level of environmental improvement, innovation on socio-economic system level, which is beyond product level, is necessary, and PSS is regarded as a target of this innovation on socio-economy. This kind of definition has a substance in it, and can be a basis for future examination.

### **(3) Previous PSS researches in Europe**

With the backgrounds that some PSS definitions stick to tangible or not, PSS concept is in the context of dematerialisation. An approach that takes up the relationship between service and material was started by the concept of "Material Input per Service unit: MIPS" proposed by Dr. Schmidt-Bleek in 1994. He understood materials in a way that all materials accompanying product and production process are for providing services, and introduced an indicator called MIPS that measures the efficiency of service provision: amount of input materials necessary to provide a certain amount of service. By analysing material flow in global scale, he made a report that developed countries need to raise material efficiency by more than ten times: the concept of factor ten.

"Factor four" was published in 1997 by Dr. Ernst von Weizsaecker et al, and "Natural capitalism" in 2000 by Mr. Paul Hawken et al. These books dealt with examples of win-win relationships between environment and business including business models of "not selling goods, but selling services", and spread the idea throughout the world.

The European Union has conducted full-fledged PSS research projects. One is a research project called "Creating Eco-Efficiency Producer Services" conducted from 1998 to 2001. The term of Eco-efficient Service was used in the project. Seven Swedish and European research institutes participated in the project in order to bring the topic of eco-efficient services into the mainstream of European business and policy-making. Examples of eco-efficient services were collected from European areas, and fact-based analyses were conducted. Policy proposals were made towards governments, and practical guidelines that are useful for developing eco-efficient service business models was prepared to business peoples. The duration of this research project coincides with the year 1998 when a workshop on Integrated Product Policy (hereinafter, IPP) was held and the year 2001 when a green paper on IPP was issued. The research project's report does not give much allocation to IPP, but it seems to have given a significant influence on IPP.

Another big research project is "SusProNet", conducted between 2002 and 2004. With a Netherlands's institute as a lead organisation, about 20 European institutes worked for developing PSS experts' network and exchanging information. SusProNet



classified PSS into three types in a large way: a) Product-oriented, b) Use-oriented, and c) Result-oriented PSS, and examined eight types of business models by further classifying the three types. A report of the research project says that most PSS types will result in marginal environmental improvements at best, and that most promising one from environmental viewpoint is "functional result-oriented type", which is one of the result oriented types of PSS. Examples of functional result oriented business models include one that provides not energy but air-conditioning services, or one that does not sell pesticides but provides services that controls the rate of harvest loss by destructive insects. SusProNet seems to have understood all products and services as PSS<sup>12</sup>, which might have caused a confusion among researchers and policymakers.

#### **(4) Previous PSS researches in the United States**

In the US, a term "servicizing" has been used. Servicing was used for the first time in a report<sup>13</sup> prepared for the US Environmental Protection Agency in 1999. The report was intended to support a report<sup>14</sup> in 1997 that proposed the concept of Extended Product Responsibility, which is different from Extended Producer Responsibility (hereinafter "EPR"). In the US, the concept that producer should have all responsibilities on used materials was not accepted, and then they settled into a concept of product responsibility, which implies shared responsibility among various stakeholders. The 1997 report shows examples of PSS business models, not selling product but services, of US-based companies. It includes leading examples on resource circulations of product items such as electronics, refrigerators, automobiles and batteries, by conducting product stewardship and product lifecycle partnership.

As the term servicing gives an image of increasing service elements, servicing seems to be a concept focusing on manufacturing industries. In 1980s, manufacturing industries in the US plunged in international competitiveness, but in 1990s recovers their business performance by "servicizing manufacturing businesses." In servicing manufacturing businesses, there are business models exist from traditional "manufacturing and selling" to "manufacturing and financing", "repair and maintenance", "insurance and assurance", "selling used-product and processed scrap", and "outsourcing." It is said that profitability increases in this order of business models, and the US manufacturing industries have taken these changes.

A research on whether servicing could reduce environmental loads has

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<sup>12</sup> The SusProNet Newsletter #1 says that "Pure products? Pure services? Forget it. There are only Product Service Systems"

<sup>13</sup> US Boston-based Tellus institute, a not-for-profit institute, prepared the report. A. White et al., 1999, Servicing: The Quiet Transition to Extended Product Responsibility

<sup>14</sup> G.A. Davis et al., 1997, Extended Product Responsibility: A New Principle for Product-Oriented Pollution Prevention

mainly conducted on CMS, which is an outsourcing service that manages lifecycle of chemical materials. An industry-based not-for-profit organisation<sup>15</sup> has conducted analysis on environmental performance etc. and reported that CMS is effective. Other servicing models have not been studied in detail.

#### **(5) Previous PSS researches in international area**

The cause of the term PSS getting attentions seems to be rest on a research project by the United Nations Environment Programme (UNEP). This research project was conducted with the participation of experts from Italy and the world during 2000 - 2002. Theory of PSS was examined, PSS cases were collected from various parts of the world and analysed, and a report titled "Product-Service Systems and Sustainability" was assembled<sup>16</sup>. In this report, PSS is regarded as a concept that has high potentiality of achieving "sustainable consumption" that goes beyond the stage of cleaner production, a business strategy of great promise, and also a new approach towards sustainability. It proposes a concept to heighten, by taking design viewpoints, efficiency of material circulation among stakeholders of product lifecycle: consumers, retailers, producers, suppliers, and used product managers. The research was conducted with a consciousness that "the agenda now, is to discuss whether the PSS concept can be considered a promising initiative in terms of its influence on sustainable production and consumption patters, and whether it is relevant now, for both industrialising and industrialised countries." This research project also recognised that PSS concept is still at an idea stage, and expects future examinations on effectiveness although admitting potentiality.

The Organisation for Economic Co-operation and Development (OECD) has conducted research projects on sustainable consumption dividing into the first phase of 1995-1998 and the second phase of 1999-2001. The research results are compiled into the 2002 report of the second phase with the title of "Towards Sustainable Household Consumption?" It examines factors or driving forces that affect final consumption pattern of products and services at households, and policy measures as well. It showed that both "hardware" that is built by activities of government and industries and "software" that formulates consumers' activities need to change, and that further examination is necessary on potentiality of information measures voluntarily coordinated for consumers. In 2004, OECD prepared a report on waste contract design and management for enhancing waste minimisation. It is intended to promote contracts for performance-based services such as ESCO or CMS. This kind of business models

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<sup>15</sup> Chemical Strategies Partnership

<sup>16</sup> UNEP(United Nations Environment Programme), 2002, Product-Service Systems and Sustainability

requires detailed contracts and tends to make transaction costs higher. In the US, performance-based contract is spread in a context of government reform, but in Japan and probably in many countries, it requires a lot of efforts.

In Japan, there are no PSS research projects funded by the government and no systematic research report. However, getting stimulated by the western researches, some researches on Japanese PSS business models are in progress.

### **3. Trends of relevant policies**

#### **(1) Environment-oriented product policy**

How PSS concept can be used for policy developments? One of the most relevant policies to PSS concept is product policy. Product policy as an environmental policy regards product itself as sources of pollution, and tries to reduce environmental loads in the product's lifecycle. The concept of environment-oriented product policy is still in a very early development stage, but there is a framework proposed that "product policy" includes "process policy" that deals with manufacturing process and "waste policy" that deals with waste disposals and targets at the whole lifecycle of products<sup>17</sup>. It does not include "substance chain policy" that deals with the relationship between eco-sphere and techno-sphere, but it is still a policy that has a huge scope, because it deals with all material flows in techno-sphere. Measures of product policy include direct regulatory instruments, economic instruments, environmental labels, voluntary agreements, consumer policy, and also new institutional arrangements like eco-leasing, sharing, and least-cost-planning<sup>18</sup>, which are PSS business models. Product policy by government and product management as a marketing strategy of corporations are distinguished. The new institutional arrangements, although listed in public policy measures, basically belong to the latter, because corporations usually adapt PSS without paying attentions to the environment.

The most relevant policy principle to PSS concept is EPR. According to a guidance manual<sup>19</sup> developed by OECD, principal goals of EPR are a) source reduction: natural resource conservation/material conservation, b) waste prevention, c) design of more environmentally compatible products, and d) closure of materials use loops to promote sustainable development. Material conservation or de-materialisation is the core of PSS concept. Closure of material use loops transforms one-way type of economic structure, gives incentives on product design that makes material circulate easily, and prevents from wastes to be produced. The manual also shows the following policy

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<sup>17</sup> F. Oosterhuis et al (1996) Product Policy in Europe: New Environmental Perspectives, Kluwer Academic Publishers

<sup>18</sup> Planning method for Demand Side Management. With this method, service provider looks into optimising systems including demand side. Applied in energy services and transportation services.

<sup>19</sup> OECD, 2001, Extended Producer Responsibility -A Guidance Manual for Governments-

measures to exercise the principles of EPR: a) take-back requirement, b) economic instruments such as deposit/refund or material taxes, c) standards such as the one that designates minimum recycled content requirements, and d) other industry-based measures such as leasing and servicizing. The fourth type of measure corresponds to PSS concept. By taking leasing business model, producer keep ownership of product (especially long-life product), and can manages whole lifecycle of products, which could reduce material usage by repair or reuse. Servicizing was, in this paper, previously referred as a concept that is born in the US and corresponds to PSS. The manual evaluates that the industry-based measures is an important trend for the future.

As stated above, in environment-oriented product policy, PSS is regarded some specific business models that work as policy tools. On the other hand, as stated at first, PSS is defined as a combination of products and services, which covers all products and services, or as a socio-economic system. These show that PSS concept needs to be developed more.

## (2) Trends of relevant policies in Europe

Table 1 shows major events of environment-oriented product policy in Europe. The first policy that introduced EPR principles is the Directive on Packaging and Packaging Waste 1994. Then, the Directive on End-of-Life Vehicles was issued in 2000, and the Directive on Waste Electrical and Electronic Equipment in 2002.

Table 1: Major Events on Environment-Oriented Product Policy in Europe

Year	Events
1994	Directive on Packaging, which incorporates EPR for the first time.
1998	Workshop on IPP
2000	Directive on End-of-Life Vehicles, which incorporates EPR.
2001	Green paper on IPP
2002	Directive on Waste Electrical and Electronic Equipment, which incorporates EPR.
2003	Commission's Communication on IPP
2004	Environmental Technologies Action Plan
2005	Directive on Energy Using Product, which incorporates IPP. Thematic strategy on the prevention and recycling of waste Thematic strategy on the sustainable use of natural resources

These directives are positioned as a "waste management policy" of EU, which consists of general frameworks such as "framework directive on waste disposal" and

"integrated pollution prevention and control", and institutions targeting at specific wastes such as packaging, used automobile, waste electronics, PCB, used batteries etc. The EPR relevant directives are applied to wastes of some specific products.

The packaging directive was first issued in 1985, but it was not widely accepted by member countries of EU, because it had lots of ambiguities. It caused problems in European market between the countries who introduced the directive and the countries who did not. In order to promote collaboration between member countries, they revised the packaging directive in 1994. This experience seems to be influential on the coming directives. In Europe, there is only one product market. So, if there exist product policy differences in member countries, material flow would be channelled lopsidedly and stable recycling would be difficult.

The three directives that incorporate EPR principles impose member countries of EU numerical targets. The packaging directive (1994) sets recovery rate and recycling rate at the end of June 2001 and December 2008. The end-of-life vehicle directive (2000) sets re-use rate, recovery rate and recycling rate by 2006 and 2015. The waste electrical and electronic equipment (2002) sets recovery rate, reuse rate and recycling rate by the end of December, 2006. However, there is a problem pointed out in setting numerical targets like recovery rate. Active transportation of used products, which is promoted by recovery rate target, accompanies more emission of greenhouse gasses. Under these circumstances, product lifecycle assessment has got attentions, which evaluates environmental loads throughout the lifecycle stages of product: resource excavation, material processing, product manufacturing, distribution and sales, use and consumption, and waste and recycling. However, product lifecycle evaluation requires significant infrastructures to be developed.

IPP is a policy concept that minimises environmental loads by looking at the whole product lifecycle and taking actions at the most effective stages. In 1998, a report<sup>20</sup> was prepared to give a framework on IPP and an analysis that the trends from product to service is not happening significantly. Expectation on IPP was raised through events like a workshop<sup>21</sup> in which governments, industries, consumers and environmental organisation participated. The green paper on IPP, which was assembled in 2001 through active discussions, says that IPP approach will primarily focus on eco-design of products and services and the creation of information and incentives for the choose and use of greener products. IPP strengthens its characteristics of voluntary measures, making a contrast to regulatory EPR. The green paper also referred that the term "product" in principle includes "all products and services", but in practice, action might address all or only certain products. It also referred that possible services can

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<sup>20</sup> Ernst Young, 1998, Integrated Product Policy, Executive Summary from the Final Report

<sup>21</sup> European Commission, 1998, Workshop on Integrated Product Policy

replace products by car sharing, voicemail, and that they have a dematerialisation potential of the "new economy." Then, it proposed local initiatives that reduce environmental loads through collaboration in local society, and various measures such as product design and product panel, which is a measure for the product's stakeholders to examine a way to achieve environmental target, as well as economic measures.

However, after the green paper, the concept of IPP lost its vigour. In the Commission's Communication on IPP<sup>22</sup> in 2003, the term "product" that includes services is limited just in the first page of the introduction part, and in the rest of the pages, product is used as a tangible one by explaining that lifecycle thinking has progressed for tangible products rather than services. Local initiatives and product panel proposed in the green paper have disappeared in the communication.

Then, the points of IPP shift towards technological issues. The Environment Technologies Action Plan, of which target is a contribution to competitiveness and economic growth, was prepared in 2004. In 2005, Directive on Eco-design of Energy Using Product<sup>23</sup>, which incorporates IPP concept for the first time, was issued. The directive is under the jurisdiction of the Enterprise and Industry Directorate General of the European Commission. On the other hand, the IPP related activities of the Environment Directorate General remain in background areas: pilot product exercises on two types of products and construction of LCA<sup>24</sup> platform.

Although the concept of product policy as an environmental policy is relatively new, it might become already obsolete according to the thematic strategies prepared in 2005, which indicate the directions of mid-long term European environmental policy. Among the seven thematic strategies, there are two thematic strategies that are relevant to PSS: one is the thematic strategy on the prevention and recycling of waste and the other is the thematic strategy on the sustainable use of natural resources. The waste thematic strategy indicated a direction that target-setting and management will be conducted by focusing not on product level but on material level. The natural resource thematic strategy indicated a direction of setting up a European wide data centre to control natural resources, which promotes material flow management and contributes to optimisation from wider perspectives. Although these future directions are innovative for environmental policy, these might drive EPR, which Europe has taken a lead in the world, into minor positions as the managed objects change from product to material.

With the emergence of IPP, where does the European EPR, which has taken

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<sup>22</sup> European Commission, 2003, Communication from the Commission to the Council and the European Parliament on Integrated Product Policy -Building on Environmental Life-Cycle Thinking-

<sup>23</sup> European Commission, directive on establishing a framework for the setting of eco-design requirements for energy using products

<sup>24</sup> LCA (Life Cycle Assessment) is a management tool to evaluate environmental loads of products etc.



initiatives of the world, go? IPP underscores lifecycle thinking, which is good, but practices are not following. LCA is a useful tool, but it just gives reference information for decision making<sup>25</sup>. So too much dependence on LCA should be avoided. Elements that can be quantified are limited. Although we make every effort to quantification, most environmental and social elements would be left un-quantified. PSS concept has contributed to IPP concept, which might end up with just criticising EPR, if PSS stands still at its concept. PSS has a large potential, but it should be recognised that it is underdeveloped at now, and that it might give negative influences to EPR.

### **(3) Trends of relevant policies in the United States**

As stated earlier, at the US federal level, EPR was not accepted and Extended Product Responsibility was coined. The idea is that management responsibility of used product is not backed by regulatory measures on manufactures, but depends on voluntary actions of manufactures, retailers etc. Voluntary actions do not necessarily avoid responsibility. In fact, some recovery and recycling activities are happening on voluntary base. Product stewardship is an approach that asks stakeholders of product lifecycle -- manufactures, retailers, users, processors etc. -- to take his/her responsibility to reduce environmental loads. As manufactures have incentives on raising productivity, cost reduction or new market development, they can fulfil their responsibility, if the incentives can be met. Actually, manufactures have started building systems for product recovery and reuse by collaborating with each other in the same trade. Voluntary activities are conducted for the products of batteries, carpets, electronics, mercury-containing products, packaging, vehicles and others. Especially as for batteries and carpets, recovery and reuse organisations<sup>26</sup> are established and managing the activities to close the material loop.

The term servicizing, which is similar to PSS, was coined in order to defend Extended Product Responsibility. Servicizing, which is spreading in manufacturing industry of the US, is expected to promote Extended Product Responsibility. Both servicizing and Extend Product Responsibility have a scope of product lifecycle and try to optimise the whole, which contribute to environmental improvement.

What are the relationship between servicizing and policies? Although servicizing cases of the typical US manufactures are introduced, specific policy measures are not taken on most servicizing cases. It is probably because companies are voluntarily adapting business models that probably contribute to environmental

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<sup>25</sup> European Commission Environment DG has a homepage of LCA platform, where it is stated that the use of LCA is merely a decision supporting tool, rather than a decision making tool. There are also limitation and points to remember on LCA.

<sup>26</sup> The recovery and reuse organisations include The Rechargeable Battery Recycling Corporation and The Carpet America Recovery Effort.

improvement in the changes of service economy without knowing environmental effects. Companies are changing voluntarily. So policy measures are not requested. However, as for CMS business model, USEPA is giving a support to a not-for-profit organisation<sup>27</sup> promoting CMS. CMS is a representative servicizing business model in the US. CMS provides lifecycle management services of chemicals: procurement, delivery, inventory, distribution, use, collection, and disposal etc. For example, traditional paint maker has sold chemicals for painting automobile, but CMS provides painting service and other lifecycle management services of paint chemicals. CMS seems to have produced an idea of a similar performance-based business model: Resource Management (RM) business model that provides lifecycle management services of wastes and materials. Both CMS and RM are regarded as waste minimisation tools along with lean manufacturing<sup>28</sup>. However, as CMS is recognised as a tool, the characteristics of "not selling goods, but selling services" seem to be disappearing. CMS meant selling functions of chemicals instead of chemicals themselves, but is recently used for a comprehensive chemical management services targeting universities etc. The concept of servicizing is getting blurred.

As for policy on environmental technology, a homepage of "Environmental Technology Opportunities Portal" is built and various policy measures are implemented. Energy Star was introduced in 1992 by USEPA as a voluntary labelling programme for computers etc. After that, it has expanded to cover air conditioner or building through collaboration with Department of Energy. At present, Energy Star is used for more than 40 product items. However, this standard is mainly focused on energy consumption at use stage, and does not have a concept of product lifecycle.

EPR also can be found in the US, where there are more than 10,000 state and local governments, who are the major regulatory organisations on waste management. Some state and local governments have introduced EPR instead of Extended Product Responsibility. For example, the Maine state government has legislated a law that stipulates producer's responsibility for used vehicles and used electronics. As for policy measures to promote PSS, there is an example of supporting car sharing. In the Bay Area of California, there is an NPO organisation<sup>29</sup> which is conducting car sharing business with the supports of local governments, universities, transportation companies and the Department of Transportation of the federal government.

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<sup>27</sup> Chemical Strategies Partnership

<sup>28</sup> "Lean" of lean manufacturing means fleshless or reduced.

<sup>29</sup> City Carshare



#### **(4) Trends of relevant policies in Japan**

The construction of 3R<sup>30</sup> policy in Japan started when "Fundamental Law for Establishing a Sound Material-Cycle Society", a basic framework law, was enacted in 2001. The law was prepared, referring to the German Closed Substance and Waste Management Act, and gives a framework that consists of the basic law and laws on waste treatment, effective use of materials, green purchasing, and recycling laws on specific products. Based on the fundamental law, a fundamental plan is prepared, and carries numerical targets<sup>31</sup> on nation-wide material flow. Among the laws, EPR is relevant mostly to the law on effective use of materials and the recycling laws. The law on effective use of materials deals with 10 industries and 69 product items and stipulates 3R that encompasses the whole product lifecycle from design, manufacturing to recover & recycling stages. The recycling laws are prepared for packaging, home appliances, food, construction material and end-of-vehicle. There is also a guideline of the Industrial Structure Council, which covers many industries and products. With these regulatory and voluntary institutions, it is said that 90% of municipal wastes and 85% of industrial wastes are targeted for recycling. In Japan, EPR of producer does not mean that producer has to pay all recycling cost. Consumers bear a cost for recycling home appliances and end-of-life vehicles. As for packaging recycling, manufactures and retailers have to pay commissioning fee, consumers have roles to discharge wastes by sorting materials according to municipal government's standards<sup>32</sup>, and municipal governments have roles to collect sorted wastes and keep them in good conditions. The cost that municipal governments pay to fulfil their responsibility exceeds the cost that manufactures and retailers pay by several times<sup>33</sup>, which has recently brought very active discussions on the sharing of roles.

Environmental label is an information measure for purchasers to select environmentally sound products. According to ISO standards, it has three types: type 1 label (environmental mark), type 2 label (self-declaration), and type 3 label (disclosure of LCA data). In Japan, type 1 label started in 1989 with 7 product items, and has expanded to cover 42 product items, and about 5,000 brands of products are certificated<sup>34</sup>. Type 3 label started in 2002, and at present standards are developed for about 50 product items<sup>35</sup>.

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<sup>30</sup> 3R means Reduce, Reuse and Recycle.

<sup>31</sup> Numerical targets of material flow are: resource productivity (about 40% improvement), recovery rate (about 40% improvement) and disposal rate (about 50% reduction)

<sup>32</sup> The number of waste sorts differs between municipal governments. There is a city that stipulates more than 20 waste sorts. Citizens who live in these cities are required to work for the detailed sorting.

<sup>33</sup> The cost of local governments is 300 billion yen annually, whereas the cost of companies is 40 billion yen annually. (Source: Ecology express 2005-12-22 Daily News)

<sup>34</sup> As of January 2005

<sup>35</sup> Product items include not only tangible products but also intangible ones such as electricity.

A most representative policy among the Japanese environment-oriented product policy would be the Top Runner Method. The Top Runner Method regulates energy consumption efficiency of products, and manufactures are obliged to develop their products' performance to the extent that exceeds the best performance available at present in a certain period. The regulation started in 1998 targeting at home appliances, and now developed to cover 18 product items including automobile. The Top Runner Method is a part of the energy saving law, which itself has expanded the objects for regulation: smaller scale of factories or business buildings and wider industries including retailers.

There are also supporting policy measures. Some new environmentally conscious industries, such as ESCO or the third party logistics, are promoted by the government. "Eco-Products" is the largest eco-related exhibition in Japan, and awards are given to providers of advanced products and services by the government. "Green Servicizing Model Program" is a programme of the government, which commissions companies or NPOs to develop good PSS type business models. It is to promote service-led business models with originality that are expected to contribute to environmental improvement more than traditional model of selling products.

The Ministry of Economy, Trade and Industry (METI) has examined environment-oriented product policy in considering the trends in Europe. In 2005, a working group of the Industrial Structure Council<sup>36</sup> has prepared a report titled "Towards a realisation of green product chain." The report proposes to pursue "innovation for life cycle thinking type social system" in order to reduce the environmental loads of products' whole lifecycle. It states the changes from quantity to quality, the formulation of green product chain by green manufactures and green consumers, and the collaboration and co-production at each stage of product lifecycle by relevant stakeholders. However, as for concrete policies for the present, the report states just "promotion of 3R design for products and manufacturing" and "measures for rare or hazardous materials contained in products." Around the same time, a study group examined measures to build win-win relationships among companies, consumers and the environment by eco-products, and took up servicizing as a measure for that. A study group on green servicizing was held, and information on Japanese PSS business practices has been collected and analysed.

In Japan, manufacturing culture is well developed. Now in the trends of service economy, Japan has an agenda of how to keep competitiveness. Manufacturing culture has developed by not only manufactures but also consumers, who request high quality of product. This can be applied to service quality such as safety or peace of mind. There

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<sup>36</sup> working group on advanced product 3R system, committee on wastes and recycling, environment bureau, the industrial structure council

would be unique PSS business models developed in Japan with elaborated socio-cultural background, and the excavations of these models are being conducted.

#### **4. Future direction for examining PSS concept**

As seen before, PSS concept is not effectively used to policy development at present. EU has conducted big research projects, and hammered out IPP that has a scope of product lifecycle. However, service is left untouched, although service is a core issue of PSS business model. The focus of dematerialisation policy is expected to shift from products to materials, which makes complex the visibility of business models that provide product-based services. In the US, CMS and RM are recognised as a tool for dematerialisation, and car sharing is supported by governments. But these seem to be all. In Japan, PSS researches have just started. While the METI supports PSS business models by an award system or by commissioning of a business model development, the Ministry of the Environment has not come up with policies other than award measures<sup>37</sup> with METI.

Although PSS concept has a great potentiality, policy measures are not developed so far. One reason might be the difficulty in quantitative measuring of environmental loads of the lifecycle of product and service. But before that, PSS concept is unclear and causing confusion, which would be the main cause of the under-utilisation. Same to servicizing or eco-efficient service that is similar to PSS. In order to utilise the idea of these, it is necessary to make clear where they are positioned in socio-economic system.

Previous researches suggest that PSS contributes to structural transformation of socio-economic system from design point of view. Many leading researchers on PSS have backgrounds on product design, and regard PSS as a system innovation of socio-economic system. A report<sup>38</sup> prepared by UNEP categorises stakeholders in the lifecycle of products and services into suppliers, producers, retailers, customers and end of product managers. Resource optimisations can be attained through designer-centred collaboration between stakeholders of a product lifecycle and its relevant products' lifecycles as well as at individual stakeholders. A report on environment-orient product policy by the Swedish Environmental Protection Agency<sup>39</sup> positioned PSS as a policy tool for eco-design.

From a design perspective, PSS, as a part of socio-economic system, can be

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<sup>37</sup> "Eco-Product Awards", which is conducted annually from FY2006, is a programme by 6 ministries: Ministry of Finance, Ministry of Health, Labour and Welfare, Ministry of Agriculture, Forestry and Fisheries, Ministry of Economy, Trade and Industry, Ministry of Land, Infrastructure and Transport, and Ministry of the Environment

<sup>38</sup> UNEP, 2002, Product-Service Systems and Sustainability

<sup>39</sup> The Swedish EPA, 2003, Towards Greener Products

expressed like Fig.3. There are three levels of design targets: product-service level, company level, and socio-economic level. The three levels are affecting each other. Product and service can be located in company level, because product is designed basically by company, and responsibility rests basically on companies even product goes out to the market. In Fig.3, arrows with both directions are meaningful. Through a product lifecycle, comments for improving product design are exchanged between stakeholders and companies through a method like a product panel. Then the companies conduct environmentally sound product design in its product-oriented environmental management system, incorporating comments from stakeholders.

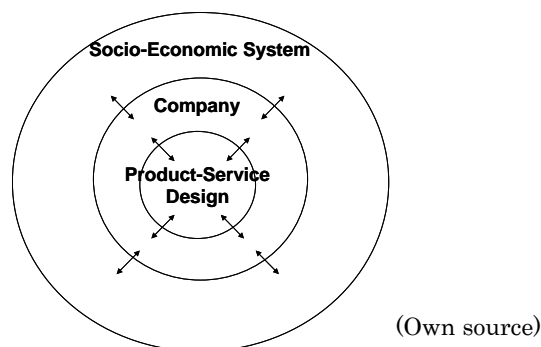


Fig.3 Conceptual Chart of PSS in a Socio-Economic System

However, a view of sustainable consumption cannot be forgotten when examining PSS concept. Sustainable production tends to be focused when PSS is regarded as a business model. The important thing is to have both viewpoints of production and consumption in socio-economic system. In general, the objectives of product policy have been to protect consumers, and regulation has been oriented towards producers. However, in order to conserve the environment, consumers are also requested to play a certain role. A series of researches on sustainable consumption by OECD have analysed factors that affect consumption pattern. Consumers are expected to participate in such activities as product sharing or used-product utilisation as well as purchasing environmentally sound products. The UNEP report includes case examples, which are more consumer-centred, such as car sharing and organic vegetables subscription system. It strikes a balance between production and consumption.

Sustainable society needs both sustainable consumption and production. Fig.4 shows the relationships between quality of life, economic growth, use of nature, and sustainable production and consumption. People are trying to increase quality of life and working for economic growth, but it needs to reduce the use of nature: the consumption of material and energy. The chart shows that decoupling of economic

growth from use of nature depends on "sustainable production", and that decoupling of quality of life from use of nature is achieved by sustainable production and consumption. Economic growth does not necessarily improve quality of life, and improvement of quality of life does not necessarily require expansion of economic growth and of material consumption. In this point, sustainable consumption is important, and attentions should be more directed to that PSS concept is relevant to sustainable consumption.

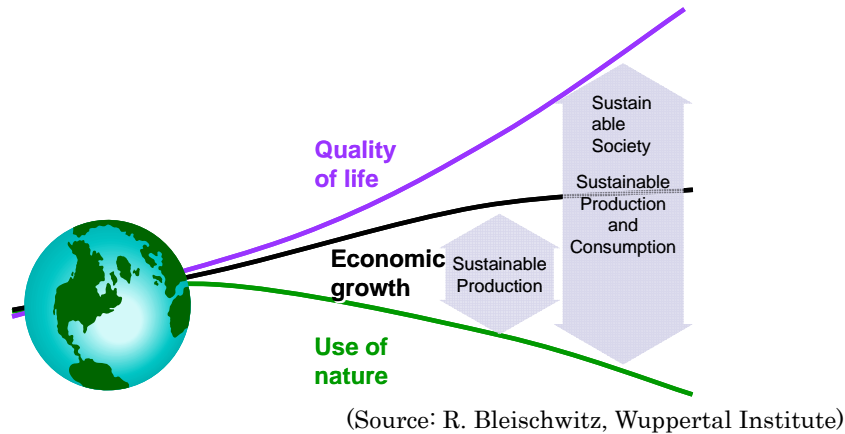
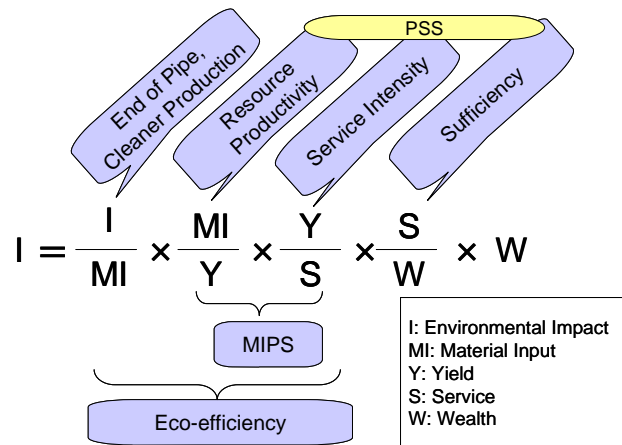


Fig. 4 Dematerialisation and Sustainable Production and Consumption

Fig.5 shows where PSS is positioned in environmental impact equation. Environmental impact consists of elements of material input, yield, service and wealth. The first term of  $I/MI$  (Environmental Impact per Material Input) refers to pollutant emissions from production process etc. Pollutant removal facility or cleaner production are the measures to make the term smaller. The second term of  $MI/Y$  (Material Input per Yield) means resource productivity. Such measures as lean manufacturing or environmental management accounting are the tools to improve resource productivity. The third term of  $Y/S$  (Yield per Service) is called as service intensity. The second term multiplied by the third term becomes  $MI/S$  (Material Input per Service): MIPS, which was introduced before. The fourth term of  $S/W$ , when inversed, leads Wealth per Service unit and can be called as sufficiency against efficiency. Sufficiency comes more from spiritual ones, and does not directly rely on the quantity of service received or yield or material consumption. Sufficiency can be improved not only by having services in pleasing manner but also by individual participation in product design or manufacturing process, and community activities for sharing the product use. Product is not just an object to consume; it can offer opportunities for people to communicate or for individual to fulfil his/her willingness to create. As a matter of fact, this kind of lifestyle is spreading in some developed countries. PSS is a concept that sees product from its whole lifecycle. Since various stakeholders are involved, PSS has various

opportunities to create a sense of wealth and belongings to the place. The concept of eco-efficiency is broad, and covers from the first term to the third term. However, it does not cover sufficiency. On the other hand, PSS covers from the second term to the fourth term. So it has the two elements of eco-efficiency and sufficiency.



(Source: FOE, (1995)<sup>40</sup>, comments by authors)

Fig.5 Environmental Impact Equation and PSS

Eco-efficiency and sufficiency need to be clearly distinguished from each other. The both can co-exist, but the mechanisms of environmental load reduction are different. Eco-efficiency contributes to the reduction of environmental loads of each product and service, but cannot deal with the holistic environmental loads because of rebound effects etc. There is a fact that increased efficiency does not reduce environmental loads when total activities increase. The example is that total greenhouse gas emission increases in spite of the spread of energy saving technologies. On the other hand, sufficiency contributes to set a limit of environmental loads from individual consumption. Especially at a matured economy, high quality of service is wanted, and the way service is provided is a matter of concern.

What is important on PSS is that it has both efficiency (producer's approach) and sufficiency (consumer's approach). Although the two approaches are different, the two are likely to direct towards the same lifestyle of post-modern society, because the relationship between producer and consumer is narrowing recent years. Prosumer<sup>41</sup>, which is a combination of producer and consumer, or a lifestyle that enjoys slow time is being spread. These are going beyond modern society, which has separated production

<sup>40</sup> Friends of the Earth Europe, 1995, Towards Sustainable Europe

<sup>41</sup> The term was originally used at "The Third Wave" of a futurist Alvin Toffler.

from consumption, and sought time efficiency. A production pattern of Linux model is also spreading from software-development to general management methods. The important thing is to integrate environmental aspects into these production style and life style. PSS has the potential for that.

## **5. Agenda for PSS researches and relevant policies**

PSS has two agendas to be utilised for policy developments: one is research agenda, and the other is agenda for relevant policies. By taking both approaches, the both are expected to develop. The followings are the conclusion of the above.

### *1) PSS concept needs to be more strengthened.*

PSS has received huge expectations for dematerialisation, but PSS research projects, which have been conducted mainly in Europe, haven't enough contributed to policy making. Future perspectives of PSS are also overshadowed. The major reason for this is that PSS concept is under-developed, and researchers and policy makers are confused on PSS. There are definitions that PSS is a combination of product and service. But, PSS needs to have a concept on its position in socio-economic system. Without a relevancy to socio-economic system, PSS would not get policy implications.

### *2) The point of PSS concept rests on the relationship between production and consumption.*

The pilot projects<sup>42</sup>, which are conducted as a part of IPP policy by EU, have significant meanings. These kinds of activities are expected to develop effective policy utilising PSS concept. It needs to be re-acknowledged that the important idea of PSS concept rests on the relationship between producer and its stakeholders: especially customer (consumer). PSS is often expressed as "not selling goods, but selling services." However, the essence of PSS concept is to readjust the relationships between producer and consumer not just at use stage, but also at the stages of product design, manufacturing, and disposal of used products.

### *3) Incorporate post-modern perspectives.*

When the relationship between producer and consumer is looked at, a departure from modern industrialism, which has separated production from consumption, and promoted mass production and mass consumption, comes into a scope.

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<sup>42</sup> IPP pilot project are conducted on two product items: mobile phones and teak garden chair. On these products, measures to reduce environmental loads through their lifecycles are examined by collaboration among stakeholders.



Future PSS concept can be developed by examining the current situation of big changes in the relationships between producer and consumer: spread of prosumer that expresses the integration of production and consumption, and of a Linux model production pattern.

PSS has the two elements: one is to improve producer's eco-efficiency and the other is to seek consumer's sufficiency. Although eco-efficiency has improved, sufficiency has had a tendency to be exempted from discussions. PSS is important, because it can deal with sufficiency.

#### *4) Towards integration of product policy and environment policy*

PSS business models have developed from voluntary activities in the market. PSS looks for new relationships between production and consumption from the viewpoint of lifecycle of product and service, and seems to occupy an important position in the future environment-oriented product policy. There are two ways of thinking to promote PSS: one is to wait for innovative business models to be produced by leaving to market mechanisms, and the other is to force business models to be changed by introducing regulations like EPR. The both are important, and the two can co-exist well. Environment-oriented product policy has been developed rapidly by EPR that requests material circulation. In the future, a system of environment-oriented product policy needs to be established by incorporating policy that raises quality of service or sufficiency.