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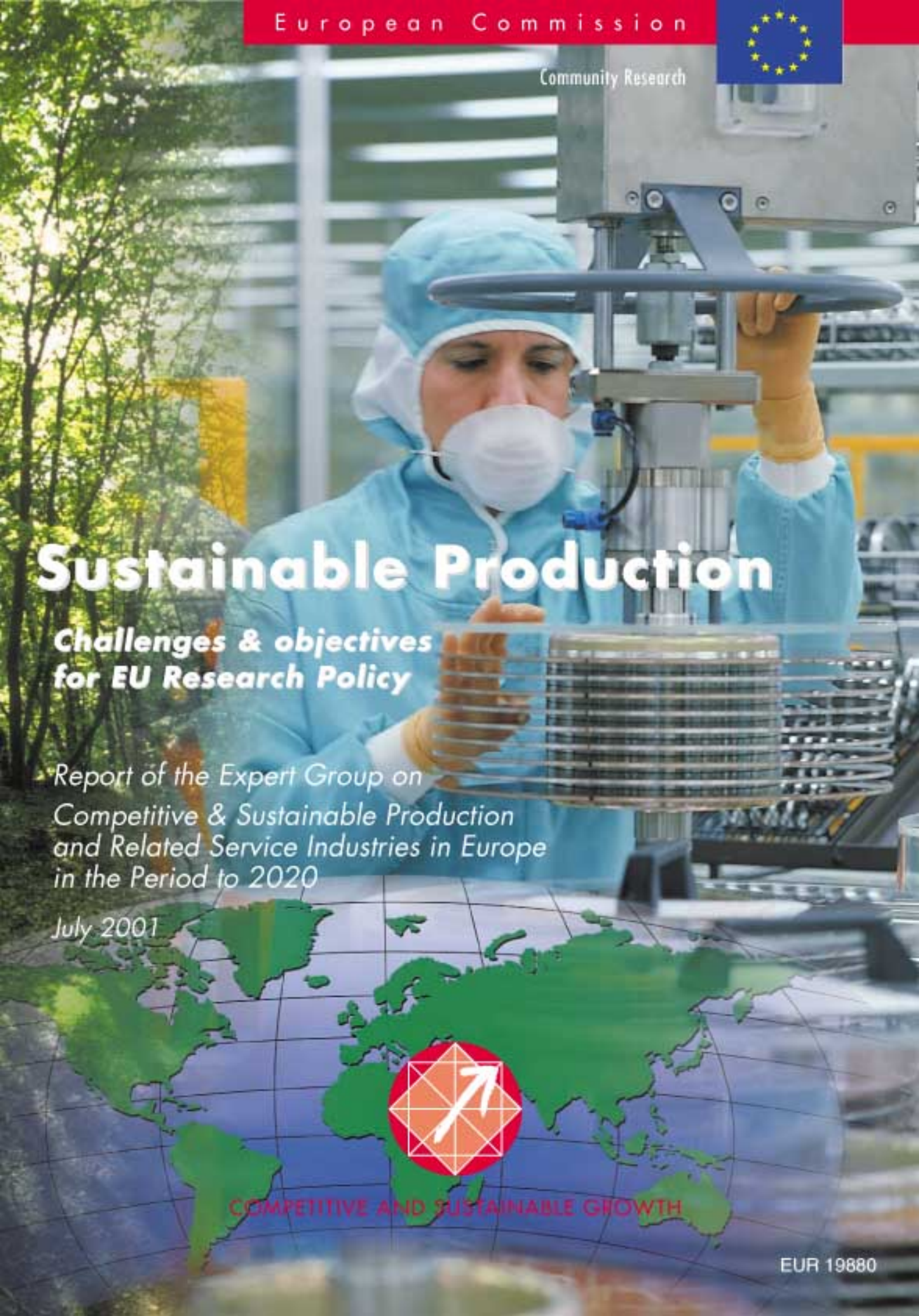

Sustainable Production

Challenges & objectives for EU Research Policy

Report of the Expert Group on Competitive & Sustainable Production and Related Service Industries in Europe in the Period to 2020

July 2001

COMPETITIVE AND SUSTAINABLE GROWTH

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FOREWORD

Purpose of the report

The production sector and its related services are central to human activity. The two major European strategic challenges binding on society, and accordingly on European industry, call for: (1) a maintenance of competitiveness and (2) a support for sustainable development.

European industry with its 40 million workers is the engine of the economy and has demonstrated the capacity progressively to decrease its environmental impact, following adequate research, technology development and innovation (RTD&I) efforts. The production sector will remain essential and of strategic importance for Europe. Facing the challenge of a competitive and sustainable European production system, in the period to 2020, will require a more integrated and encompassing vision of RTD&I policies that takes account of economic, environmental and social dimensions.

This study was initiated and funded by the "Competitive and Sustainable Growth" Programme of the EU Research Directorate. The purpose of this report is to address:

- the specific objectives and priorities for EU RTD&I policy, and in particular actions to be supported at EU level;
- the appropriate combination of means of action to achieve these objectives, consistent with the broad policy framework defined in the Commission's communication "Towards a European Research Area";
- the articulation and complementarity between research policy and other policies, and between their instruments.

The Expert Working Group

The Working Group on "Competitive and Sustainable Production and Related Service Industries in Europe" was established by the Commission services using Experts drawn from the STRATA (Strategic Analysis) data base. This group met six times in 2000-01 to consider the requirements for competitive and sustainable production systems in Europe (in the period to 2020) and the implications for RTD&I EU policies. It started with an integrated view of the arena of innovation, which sees production and consumption as key parts of socio-technical systems that include technologies, production, products and materials in use.

The group began its work using the linear concept of "efficiency" (seeking lower inputs for a given activity) but then moved on to focus on the concept of "sufficiency", concerned with the search for, and implementation of, new ways to meet users' needs (notably services, meeting needs through the performance of material products). The concept of sufficiency was addressed because it was seen likely as the most significant development during the prospective period to 2020. The group then made its own recommendations concerning the objectives, scope, content and instruments of appropriate RTD&I policies.

The meetings were attended by Commission officials, who participated in the discussions and contributed information on EU policies and programmes.

The contents of the report are the sole responsibility of the working group, whose views do not necessarily reflect those of the Commission.

AVANT PROPOS

Objet du rapport

Le secteur de la production et les services associés à cette production occupent une place centrale dans l'activité humaine. Les deux défis stratégiques majeurs pour la société européenne, et par conséquent pour son industrie, sont: (1) le maintien de sa compétitivité et (2) le soutien d'un mode de développement durable.

L'industrie européenne avec ses 40 millions d'emplois est le moteur de l'économie. Elle a démontré sa capacité de limiter progressivement son impact sur l'environnement, suite à des efforts adéquats de recherche et développement technologique et d'innovation (RDT&I). Le secteur de la production restera essentiel et d'une importance stratégique pour l'Europe. Face au défi d'un système Européen de production compétitif et durable à l'horizon 2020, une vision plus intégrée des politiques de RDT&I sera nécessaire, tenant compte des dimensions économique, environnementale et sociale.

Cette étude fut lancée et financée par le programme « Croissance compétitive et durable » de la DG Recherche de la Commission Européenne. L'objet de ce rapport est de traiter :

- les objectifs et priorités spécifiques pour la politique européenne de RTD&I, et en particulier les actions à soutenir au niveau communautaire,
- la combinaison appropriée de moyens d'action pour atteindre ces objectifs, en cohérence avec le cadre plus large de la politique définie dans la communication de la Commission « Vers un Espace Européen de Recherche »,
- l'articulation et la complémentarité entre politique de recherche et autres politiques et entre leurs instruments.

Le groupe de travail

Le groupe d'Experts sur la « Production compétitive et durable et les services associés à cette production en Europe » a été établi par les services de la Commission, invitant des Experts à partir de la liste STRATA (Strategic Analysis). Ce groupe s'est réuni 6 fois en 2000-2001 pour étudier les exigences des systèmes européens de production compétitifs et durables à l'horizon 2020 et les implications pour les politiques européennes de RDT&I. Le point de départ des travaux était une vue intégrée de l'innovation, qui considère que la production et la consommation sont des parties clés des systèmes socio-techniques qui incluent technologies, production, produits et matériaux utilisés.

Le groupe a commencé ses travaux avec le concept linéaire d'« efficacité » (chercher la diminution des entrées d'un système pour un résultat donné) pour ensuite concentrer son attention sur le concept de « suffisance ». Ce dernier concerne la recherche et la mise en application de nouvelles manières de satisfaire les besoins des utilisateurs (notamment de services qui satisfont les besoins par la performance). Ce concept de suffisance a été mis en avant car il sera probablement le développement le plus significatif à l'horizon 2020. Le groupe a formulé par la suite ses recommandations concernant les objectifs, la portée, le contenu et les instruments de politiques de RDT&I appropriées.

Les réunions du groupe ont été suivies par des responsables de la Commission qui ont participé aux discussions et ont fourni des informations sur les politiques et programmes européens de recherche.

Le contenu du présent rapport n'engage que la responsabilité du groupe d'Experts, dont les opinions ne reflètent pas nécessairement celles de la Commission.

VORWORT

Zweck des Berichts

Der Produktionssektor und die damit verbundenen Dienstleistungen sind im Mittelpunkt jeder menschlichen Tätigkeit. Die zwei wichtigsten strategischen Herausorderungen in Europa, die für die Gesellschaft und damit auch für die europäische Industrie gelten, sind : (1) Die Aufrechterhaltung der Wettbewerbsfähigkeit und (2) Unterstützung für nachhaltige Entwicklung.

Die europäische Industrie mit ihren 40 Millionen Arbeitnehmern ist der Motor für die Wirtschaft. Sie hat im Anschluss an angemessene Forschungs- und technologische Entwicklungsbemühungen ihre Befähigung nachgewiesen nach und nach die Umwelteinwirkungen abzubauen. Der Produktionsektor wird weiterhin unentbehrlich sein und strategische Bedeutung für Europa beibehalten. Wenn man sich den Herausforderungen für ein wettbewerbsfähiges und nachhaltiges Produktionssystem stellt, braucht man in der Periode bis 2020 eine integrierte und umfassende Vision der Forschungs- und technologischen Entwicklungspolitiken einschliesslich einer Innovationspolitik, die die ökonomische und gesellschaftliche sowie die Umweltdimension umfasst.

Diese Studie wurde von dem Programm « Wettbewerbsorientiertes und nachhaltiges Wachstum » des Forschungsdirektorats der Europäischen Kommission angestossen und finanziert. Zweck dieses Berichts ist folgendes anzusprechen :

- Die spezifischen Ziele und Prioritäten für eine Europäische Forschungs- und technologische Entwicklungspolitik einschliesslich Innovationspolitik und insbesondere die Aktionen, die auf europäischer Ebene unterstützt werden sollen ;
- Die angemessene Verbindung von Mitteln und Wegen, um die Ziele zu erreichen, die im Einklang mit dem breiten politischen Rahmen stehen, der in der Mitteilung der Kommission « Hin zu einem europäischen Forschungsraum » festgelegt sind ;
- Die Verbindung und Ergänzung zwischen Forschungspolitik und anderen Politiken und ihren Instrumenten.

Die Arbeitsgruppe der Sachverständigen

Die Arbeitsgruppe « Wettbewerbsorientierte und nachhaltige Produktion und verwandte Dienstleistungsindustrien in Europa » wurde von den Kommissonsdiensten unter Rückgriff auf Experten aus der STRATA (Strategische Analyse) Datenbank eingerichtet. Sie hat sich in 200/2001 insgesamt sechsmal getroffen, um die Auswirkungen und Anforderungen von wettbewerbsorientierten und nachhaltigen Produktionssystemen in Europa (für den Zeitraum bis 2020) hinsichtlich der Forschungs-, technologischen Entwicklungs- und Innovationspolitiken in Europa zu erörtern. Die Gruppe begann mit einer Gesamtschau im Innovationsbereich die Produktion und Verbrauch als Schlüssel des sozio-technischen Systems begreift. Dieses umfasst Technologien, Herstellung, Produkte, und die verwendeten Materialien.

Die Gruppe hat bei Aufnahme ihrer Arbeit ein lineares Konzept von « Effizienz », d.h. Verringerung des Inputs für eine gegebene Aktivität benutzt, sich dann aber auf das Konzept von « Angemessenheit » konzentriert, das sich mit der Suche nach und dem Beschreiten neuer Wege zur Erfüllung der Bedürfnisse von Benutzern/Verbrauchern (insbesondere Dienstleistungen, Erfüllung von Bedürfnissen durch Leistung von materiellen Gütern) befasst. Die Gruppe war der Auffassung, dass das Angemessenheitskonzept die bedeutsamste Entwicklung während der

Vorhersageperiode bis 2020 darstellen könnte. Die Gruppe gab dann ihre eigenen Empfehlungen hinsichtlich Ziele, Umfang, Inhalt und Instrumente einer angemessenen Forschungs-, technologischen Entwicklungs- und Innovationspolitik.

An den Besprechungen nahmen auch die Mitarbeiter der Kommission teil ; sie beteiligten sich an den Diskussionen und trugen durch Information über die europäischen Politiken und Programme bei.

Für den Inhalt des Berichts ist ausschliesslich die Arbeitsgruppe zuständig. Deren Ansichten geben nicht unbedingt die Auffassung der Kommission wieder.

EXECUTIVE SUMMARY

1. This report provides strategic guidance for future EU policies and actions in support of research, technology development and innovation (RTD&I) in relation to production and related service industry sectors. It addresses how RTD&I can contribute to competitive and sustainable European production systems in the period to 2020.

2. The context is that production systems have considerable economic, environmental and social significance. Presently, manufacturing contributes some 20% of European gross value added, employs around 30% of the European workforce and contributes about 25% of the waste, green house gasses and NO_2 generated in Europe.

3. Three cornerstone issues frame the report:

- The European system of production is not sustainable and has not begun to address in a substantive way how competitiveness can be achieved within the framework of sustainability and at the same time maintain an acceptable quality of life.
- Current trends in the modernisation of production have the potential to improve competitiveness and to reduce environmental impacts but are unlikely to bring production, and the use of products, within the framework of sustainability.
- Present EU policies and actions for RTD&I might improve environmental performance but will not foster the transformations in production that are required to achieve competitiveness within the framework of sustainability during the prospective period.

4. The Expert Group developed a vision of a European system of production for the prospective period in which:

   Human ingenuity [knowledge and technology], capital, resources and needs are harnessed and governed so people can live better lives while consuming less material resources and energy. This system is sustainable when production and consumption support the quality of individual and social life, in ways that are economically successful while respecting environmental limits within the changing context of local-global conditions.

5. **This vision requires a more integrated view of the arena of innovation, with a focus on sufficiency.** The report outlines the thinking that guides this orientation, rather than setting out more concrete policies and actions. This fits with the notion that, innovations have to be designed by actors who know a specific production system, rather than by a small group of experts who met in Brussels during the year 2000. The report's central argument is that this orientation is the necessary pre-requisite for new policies, actions and practices customised to the needs of different systems.

6. A more integrated view of the arena for innovation sees production and consumption as key parts of socio-technical systems. Socio-technical systems include technologies, products and materials 'in use' and human systems. Examples of socio-technical systems are information and communication, mobility, or household services, such as clean clothes or nutrition. Innovations arise through design – purposeful processes of change that engage many actors [producers, consumers and others]. An integrated view has other dimensions. It brings together economic, environmental, social and scientific concerns. It requires solutions tailored to specific socio-technical systems and localities under the influence of national, European and global pressures.

A particular issue is the way globalisation is creating new axes for the governance of technological and social innovations. This means future innovation must be governed in ways that are responsive to global competitiveness and innovation, environmental concerns and social needs, while harmonising public policies and business strategies through collaboration and joint action. This runs counter to most existing policies and practices for RTD&I. It has implications for the orientation of environmental and industrial policies as well as industrial practice.

7. This orientation builds on a number of trends in manufacturing and adopts some known and simple principles. For example, production is becoming progressively more resource efficient, there is an increasing number of examples of closed-loop production on which to draw, and manufacturers are increasingly addressing consumers' needs for product performance. There is also a strong link between the development of knowledge and innovation, as the foundation for competitiveness, and, the achievement of environmental and social sustainability. This link is provided by ideas about learning organisations and multi-actor [social] learning platforms. These emphasise collaborative processes for developing visions, systems thinking, problem finding and problem solving, and resolving barriers to change and joint action.

8. The innovations arising out of this process are either context-taking or context-breaking. They fit within one of two archetypes – efficiency or sufficiency. Efficiency is a linear concept seeking lower inputs for a given activity. Sufficiency is concerned with the search for, and implementation of, new ways to meet human needs. Sufficiency addresses the services required to meet needs and the performance of material products. Illustrations of sufficiency are selling flooring services not carpets, providing photocopied documents rather than photocopiers, or selling clean clothes or cold food rather than washing machines or refrigerators. In sufficiency solutions manufacturers retain ownership of the material in physical products and sell the service performance of those products to customers. **The group advocates that EU RTD&I policies and action should support and foster context-breaking based on sufficiency. This is seen as a proper focus of future EU policies and actions for RTD&I for the prospective period to 2020.**

9. There are a limited but growing number of innovations that illustrate the sufficiency archetype. Implementing these innovations frequently encounters institutional, organisational and managerial obstacles. Some obstacles are generic others are specific to individual innovations and socio-technical systems. Development and implementation of sufficiency solutions requires these obstacles to be overcome as part of the innovation process.

10. Obstacles to sufficiency and to the collaborative processes on which organisational and social learning for sufficiency is based include:

- Different management styles and cultures in Europe [this obstacle should not be overcome by reducing the diversity of the European system, as diversity is a potential source of innovation].
- Different cultural and linguistic approaches to collaborative processes.
- Lack of coherence and perverse incentives in the overall mix of policies [for example taxes, subsidies, capital write-offs, and trade agreements are often contradictory and do not support sufficiency and sometimes not even economic and environmental efficiency].

- Weak participation by the private sector in public policy making and weak collaboration between private and non-governmental interests.
- Relatively low levels of co-operation and collaboration in research and innovation.
- Absence of initiatives that bring together potential partners across sectors and interests.
- Inability of consumer groups and other actors to engage effectively in learning and innovation programs.
- Risk aversion in committing resources and forging new organisational collaborations around innovations.
- The low disposition of organisations to support life-long learning at all levels of enterprises.
- Shortages of capabilities in systemic thinking and systems integration.
- Scarcity of facilitation skills and the skills to support multi-actor, multi-disciplinary, multi-functional, multi-sectoral processes.
- Poor mechanisms to diffuse good practice in learning and knowledge development.
- Continuing confusion between environmental management and sustainable development.

11. Accelerating the shift toward sufficiency requires broader, more flexible, policy instruments than are provided by the present support for collaborative R&D projects. For example through:

- 100% funding of search exercises for key socio-technical systems to generate ideas about, and commitments to, sufficiency solutions through the moderation of material consumption and sustainable product service offerings.
- Funding support for remodelling R&D infrastructure and the innovation system to reflect the new demands for knowledge, the new context for interaction with industry and the requirements for new skills and competencies.
- An important new element of innovation infrastructure is the establishment of international competence networks as a basis for research and the dissemination of research results. These networks should be set up for a period of 5-10 years [maximum], equipped with a [relatively] stable budget and working to a remit that emphasises communications. These competence networks should form nodes in a broad Europe-wide communications and co-operation network.
- Restructuring RTD&I policy administration so it reflects the participative processes that are being encouraged for RTD&I – i.e. policy administration should be multi-disciplinary and participative, experimental and possibly open to continuous interaction with EU experts and supported RTD&I partnerships. This might involve experimentation with continuous process evaluation and mid-term corrections in projects.

12. **A 'design framework' of six concurrent processes is proposed as a response to the deficiencies of the present system of RTD&I and the obstacles to sufficiency in Europe. These are:**

The generation of ideas for innovative approaches to sufficiency strategies for selected socio-technical systems:

- Foresight forums through which societal groups generate new ideas and learn about the expectation of relevant actors for competitiveness within the framework of sustainability in relation to specific socio-technical systems.

- Maximum encouragement for maverick, or wild card, approaches to RTD&I through a continuously open call within the theme Competitive and Sustainable Development.
- Specific funds designated for innovations, which have merit but do not meet traditional criteria.

Understanding Socio-Technical Systems:

- Participative forums to establish the key actors involved in specific socio-technical systems, and, to identify and map the specific characteristics of those systems together with actors' needs and interests.
- Establishing the basis for inputs and contributions by actors to collaborative action.

Resolving the barriers to change and establishing the feasibility of solutions:

- Addressing knowledge transfer problems and organisational barriers for companies, which want to adopt competitive strategies for sufficiency.
- Establishing appropriate cost-accounting and financial control mechanisms that reflect the true economics of material recovery and material assets held in product-related service performance systems.
- Schemes to develop competence in designing for service-performance rather than in producing products so workers can become service providers.
- Supporting inter-firm co-operation using information technology & knowledge management and logistics, especially on reverse supply chains and take-back schemes.
- Establishing and resolving barriers arising from the demand for venture capital oriented toward competitive sustainable development projects.
- Identifying a policy mix that supports sufficiency in specific socio-technical systems.

Supporting the development and adoption of enabling technologies:

- Emphasising basic science and research in technologies, which allow decentralisation of systems. Highlighted areas are information and communication technologies, biotechnology and micro and nano-technologies. These represent important enabling technologies in the areas of dematerialization and resource productivity.

Engaging a variety of relevant actors to participate in the process of learning and change:

- Incorporating societal and environmental actors together with business managers in programme committees of the Framework Programme.
- Broaden the knowledge base on sustainability innovation mechanisms in manufacturing practice. Carry out socio-economic research on sustainability management and innovation management within competitive frameworks as well as introduce a voucher system for societal groups, which allows them – if collaborating – to give research grants.
- Developing the contribution of socio-economic experts as a support input/vision to RTD&I on social needs.
- Training participants in effective multi-actor procedures and the facilitation of processes.

Demonstrating and disseminating these processes and their outcomes to others:

- Assessing and developing a policy-mix that encompasses legislation and taxation that allows technical alternatives [through R&D for technology] to be examined in advance of drafting directives etc.

- R&D in hard sciences in support of areas of public sector spending where the objective is the promotion of competitive and sustainable solutions.
- Action research on the demonstration of the principles for future production systems in action, and demonstration of participation in action.
- Multi-actor Implementation Forums for RTD&I and sustainability combined with competitiveness at levels appropriate to specific socio-technical systems.
- Database and resource guides on good practices of SMEs involved in competitive approaches to sufficiency [particularly for companies not in existing networks].
- Socio-economic shadowing of the process of mainstream RTD&I research with monitoring in real time, with the objective of presenting challenges, learning and disseminating rather than evaluating policy implementation.

13. **This design framework should be guided by principles such as – lightness, flexibility, durability, adaptability, and closed material loops. The framework involves processes based on collaboration for mutual learning and action. These principles and processes provide the elements of a 'design guide for sufficiency'.**

14. There are opportunities for international co-operation and collaboration in line with this approach. For example:

- Co-operation with other developed, industrial economies on key global challenges of industrial development based on sufficiency
- Concerted unilateral or multilateral support to developing countries to embed pathways to development based on sufficiency
- Co-operation with developing economies and economies in transition that tailor solutions to their unique circumstances and needs
- In developing countries, commitment to capacity building in terms of the transfer of capabilities and skills, especially those related to systems integration and the development of improved processes of participative technology assessment and development.

RÉSUMÉ

1. Le présent rapport propose des orientations stratégiques pour guider les politiques et actions futures de l'UE en matière de recherche, de développement technologique et d'innovation (RDT&I). Il s'intéresse plus précisément à deux secteurs: celui de la production et celui des services liés à la production. Il examine comment la RDT&I peut contribuer à mettre en place des systèmes de production compétitifs et durables en Europe d'ici à 2020.

2. Les systèmes de production ont une importance économique, environnementale et sociale considérable. Aujourd'hui, la production manufacturière représente quelques 20 % de la valeur ajoutée brute européenne, emploie environ 30 % de la main-d'œuvre européenne et contribue à un quart de la production européenne de déchets, de gaz à effet de serre et de NO_2.

3. Le rapport traite de trois aspects cruciaux de cette problématique:

- Le système européen de production n'est pas durable. Mais la question des conditions de sa compétitivité dans un cadre durable et compatible avec une qualité de vie acceptable, n'a pas encore été sérieusement posée.
- Les tendances actuelles de la modernisation de la production peuvent certes améliorer la compétitivité et réduire les incidences sur l'environnement. Mais il est peu probable qu'elles parviennent à placer d'elles-mêmes la production et l'utilisation des produits dans les conditions d'un développement durable.
- Les politiques et actions actuelles de l'UE en matière de RDT&I pourraient améliorer les performances environnementales. Mais de telles politiques ne favoriseront pas les transformations qui sont nécessaires au niveau de la production pour la rendre compétitive dans des conditions de développement durable pendant la période considérée.

4. Le groupe d'experts a développé une vision de l'avenir du système de production européen dans laquelle:

   L'intelligence humaine (savoir et technologie), le capital, les ressources et les besoins sont maîtrisés et gérés de telle sorte que les gens peuvent vivre mieux tout en consommant moins de ressources matérielles et moins d'énergie. Ce système est durable si la production et la consommation permettent une vie individuelle et sociale de qualité, d'une manière réussie sur le plan économique, tout en respectant les limites que pose l'environnement dans le contexte changeant des conditions locales-globales.

5. **Cette vision nécessite une approche plus intégrée dans le domaine de l'innovation, qui mette l'accent sur la notion de "suffisance".** Le rapport met en lumière les formes de pensées qui sous-tendent ces orientations sans aller jusqu'à proposer des politiques et des actions plus concrètes. Cette réserve est conforme à l'idée que les innovations dans chaque système de production spécifique doivent être conçues par les acteurs connaissant bien ce système et non par un petit groupe d'experts réunis à Bruxelles en l'an 2000-01. Mais le rapport part du principe que l'adoption de telles orientations est un pré-requis nécessaire à de nouvelles politiques, actions et pratiques qui soient bien adaptées aux besoins des différents systèmes.

6. Lorsque les champs de l'innovation sont approchés de façon plus « intégrée », les modes de production et la consommation deviennent des parties essentielles des systèmes socio-

techniques. Les systèmes socio-techniques englobent ainsi les technologies, les produits et les matériaux "en usage", ainsi que les systèmes humains. On appelle, par exemple, système socio-technique l'information et la communication, la mobilité, ou encore les services aux ménages, tels que le nettoyage des vêtements ou l'alimentation. Les innovations se réalisent au moyen de processus de changements délibérés qui font intervenir un grand nombre d'acteurs [producteurs, consommateurs, et autres.]. Une vision intégrée de ces processus leur reconnaît des dimensions supplémentaires. Elle regroupe des préoccupations de caractère économique, environnemental, social et scientifique. Elle exige que les solutions soient spécifiquement adaptées aux systèmes socio-techniques et aux conditions locales tout en tenant compte de l'influence des pressions nationales, européennes et mondiales.

Un aspect particulier de cette approche est donc la manière dont la mondialisation crée de nouveaux axes de gouvernance des innovations technologiques et sociales. Cela signifie que, l'innovation devra être gérée à l'avenir de façon à mieux répondre aux enjeux de la compétitivité et de l'innovation au niveau mondial de même qu'aux préoccupations environnementales et besoins sociaux. Cela signifie aussi que les politiques publiques et les stratégies commerciales devront s'harmoniser en collaborant et en agissant conjointement. Cette approche va à l'encontre de la plupart des politiques et pratiques actuelles en matière de RDT&I. Elle influencera l'orientation des politiques environnementales et industrielles ainsi que les pratiques industrielles.

7. Cette orientation repose sur certaines tendances de la production manufacturière et sur quelques principes simples bien connus. Ainsi, la production est de plus en plus efficiente dans son utilisation des ressources. Il existe de plus en plus d'exemples de production en cycle fermé dont on peut s'inspirer. Et les producteurs répondent dans une mesure croissante aux besoins des consommateurs en ce qui concerne les performances des produits. Il existe aussi un lien solide entre, d'une part, le développement du savoir et l'innovation en tant que fondements de la compétitivité et, d'autre part, la réalisation d'un développement durable sur les plans social et environnemental. Ce lien est assuré par les idées nouvelles qui se développent sur les organisations en apprentissage permanent (les "learning organisations") et sur les "plates-formes d'apprentissage" où interviennent de nombreux acteurs. Ces idées mettent l'accent sur les processus de collaboration en vue d'élaborer des visions systémiques et des méthodologies permettant de détecter et de résoudre les problèmes, afin d'éliminer les entraves aux changements et aux actions conjointes.

8. Les innovations qu'engendre ce processus sont soit en phase, soit « en rupture avec le contexte » (« context breaking »). Elles entrent dans un des deux archétypes suivants : l'"efficience" ou la "suffisance". L'"efficience" est un concept linéaire visant la réduction des inputs engagés dans la réalisation d'une activité donnée. Quant au concept de "suffisance", il concerne la recherche et la mise en œuvre de nouveaux moyens de satisfaire les besoins humains. La "suffisance" s'intéresse aux services nécessaires pour satisfaire les besoins de produits matériels et pour améliorer leurs performances. Il s'agit par exemple de vendre des services de recouvrement de sols et non des tapis, de fournir des documents photocopiés plutôt que des photocopieurs, des services de nettoyage de vêtements ou de réfrigération des aliments plutôt que des machines à laver ou des réfrigérateurs. Dans les solutions axées sur la "suffisance", les fabricants conservent la propriété des matériaux utilisés dans des produits physiques et vendent à leurs clients les services que procurent ces produits. **Le groupe plaide pour que les politiques et les mesures de RDT&I communautaires aillent dans le sens d'une rupture avec le contexte, sur la base du principe de la "suffisance". C'est sur cet**

aspect que doivent se concentrer les politiques et les actions communautaires futures dans le domaine de la RDT&I pour la période d'ici à 2020.

9. Le principe de "suffisance" n'a encore donné lieu qu'à un petit nombre d'innovations, mais ce nombre va croissant. La mise en œuvre de ces innovations rencontre souvent des obstacles au niveau des institutions, de l'organisation et de la gestion. Certains obstacles sont génériques, tandis que d'autres sont liés aux spécificités de certaines innovations et de certains systèmes sociotechniques. L'élaboration et la mise en œuvre de solutions axées sur la "suffisance" exigent que l'élimination de ces obstacles fassent partie du processus d'innovation.

10. Les obstacles à la "suffisance" et aux processus de collaboration qui constituent les bases organisationnelles et sociales de la "suffisance" sont les suivants :

- Les différences de modes de gestion et de cultures qui caractérisent l'Europe [obstacle qui ne peut toutefois être éliminé en réduisant la diversité européenne, car elle est une source potentielle d'innovations].
- Les différences d'approches culturelles et linguistiques des processus de collaboration.
- Le manque de cohérence et l'existence d'incitants à effets pervers qui caractérisent l'ensemble des politiques en vigueur [par exemple, les taxes, les aides, les amortissements et les accords commerciaux sont souvent contradictoires et incompatibles avec le principe de "suffisance". Il arrive même qu'ils ne soient pas compatibles avec le principe d'"efficience" économique et environnementale].
- La faible participation du secteur privé à l'élaboration des politiques publiques et la faible collaboration entre les acteurs privés et non gouvernementaux.
- Le niveau relativement peu important de coopération et de collaboration en matières de recherche et d'innovation.
- L'absence d'initiatives rassemblant des partenaires potentiels autour d'objectifs transcendants les secteurs et les intérêts.
- L'incapacité de groupes de consommateurs et d'autres acteurs de s'engager réellement des programmes d'apprentissage et d'innovation.
- L'aversion aux risques liés à l'engagement de ressources nouvelles et à la constitution de nouveaux types de collaboration organisée autour des innovations.
- La faible disposition des organisations à soutenir un apprentissage tout au long de leur vie à tous les niveaux des entreprises.
- Le manque de capacités en matière de pensée systémique et d'intégration des systèmes.
- Le manque d'aptitudes en matière de facilitation et en matière de soutien des processus multi-acteurs, multidisciplinaires, multifonctionnels et multisectoriels.
- La faiblesse des mécanismes de diffusion des bonnes pratiques dans le domaine de l'apprentissage et du développement des connaissances.
- La persistance de la confusion entre la notion de gestion environnementale et celle de développement durable.

11. Pour accélérer la transition vers la "suffisance", il faut des instruments plus larges et plus souples que ceux qui existent pour soutenir actuellement les projets de R&D en collaboration. On peut envisager les instruments suivants :

- Le financement à 100% d'expériences réalisées dans les principaux systèmes socio-techniques pour produire des nouvelles idées et des engagements porteurs de solutions réalisant la

"suffisance" en réduisant la consommation de ressources matérielles et en accroissant l'offre de services de produits durables.

- L'aide financière pour remodeler les infrastructures de R&D et le système d'innovation de façon à refléter les nouvelles demandes de connaissances, le nouveau contexte des interactions avec l'industrie et les exigences en matière d'aptitudes et de compétences nouvelles.
- Un important nouvel élément de l'infrastructure d'innovation est la mise en place de réseaux de compétences internationaux comme base pour la recherche et pour la diffusion des résultats de la recherche. Ces réseaux doivent être établis pour une période de cinq à dix ans [au maximum], doivent être pourvus d'un budget [relativement] stable et fonctionner selon un cahier des charges mettant l'accent sur les communications. Ces réseaux de compétences doivent constituer des "nœuds" dans un large réseau de communications et de coopération à l'échelle européenne.
- La restructuration de l'administration de la politique de RDT&I de façon à ce qu'elle reflète les processus en participation encouragés pour la RDT&I. Ceci signifie que l'administration des politiques doit être multidisciplinaire et participative, expérimentale et éventuellement ouverte à une interaction continue avec des experts communautaires et des partenariats de RDT&I subventionnés. Un tel changement pourrait nécessiter des expériences en matière d'évaluation continue des processus et des aménagements des projets à mi-parcours.

12. **Un "cadre conceptuel" définissant six processus concurrents est proposé pour remédier aux lacunes du système de RDT&I actuel et pour éliminer les obstacles à la "suffisance" en Europe. Il s'agit des processus suivants:**

La création d'idées générant des approches innovantes des stratégies de "suffisance" relative à certains systèmes socio-techniques:

- Des forums de prospective permettant aux groupes sociétaux de produire de nouvelles idées de ce type et d'apprendre ce que veulent les parties concernées par certains systèmes socio-techniques pour assurer la compétitivité dans le cadre du développement durable.
- L'encouragement maximal d'approches originales voire inattendues de la RDT&I par un appel ouvert en permanence dans le cadre du thème de recherche intitulé "Développement concurrentiel et durable".
- La création de fonds spécifiques conçus pour les innovations qui sont intéressantes mais ne répondent pas aux critères traditionnels.

La compréhension des systèmes socio-techniques :

- Des forums participatifs pour identifier les principaux acteurs concernés dans des systèmes socio-techniques spécifiques, et pour identifier et cartographier les caractéristiques spécifiques de ces systèmes ainsi que les besoins et intérêts des différents acteurs.
- L'établissement des cadres dans lesquels puissent s'inscrire les apports de contributions des différents acteurs des collaborations envisagées.

L'élimination des entraves au changement et l'établissement de la faisabilité des solutions :

- L'examen des problèmes de transfert de connaissances et d'entraves organisationnelles concernant les entreprises désireuses d'adopter des stratégies concurrentielles pour la "suffisance".

- La mise en place des mécanismes de contrôle comptables et financiers adéquats reflétant les aspects économiques réels du recyclage des matériaux et des actifs en matériaux dans les systèmes de services relatifs aux produits.
- La mise en place de programme pour développer les capacités de conception de services performants (plutôt que des produits) pour que les travailleurs puissent devenir des fournisseurs de services.
- Le soutien à la coopération inter-entreprises au moyen de technologies de l'information et de gestion et de support logistique des connaissances, notamment en ce qui concerne les chaînes d'approvisionnement inverses et les systèmes de reprise.
- L'identification et l'élimination des entraves à la demande de capital à risques pour des projets concurrentiels dans le domaine du développement durable.
- La définition d'un ensemble de mesures politiques capables de créer les conditions de la "suffisance" pour des systèmes socio-techniques spécifiques.

Le soutien du développement et de l'adoption de technologies de base :

- Le renforcement des sciences et de la recherche fondamentale dans les technologies permettant de décentraliser les systèmes, surtout dans les technologies de l'information et des communications, de la biotechnologie, des microtechnologies et des nanotechnologies. Ces technologies jouent un grand rôle dans le domaine de la dématérialisation et de l'amélioration de la productivité des ressources.

L'engagement d'un large éventail des acteurs concernés dans le processus d'apprentissage et de changement :

- L'introduction des acteurs sociaux et environnementaux ainsi que des entrepreneurs dans les comités du Programme-cadre.
- L'élargissement de la base des connaissances relatives aux mécanismes d'innovation dans les pratiques de fabrication qui favorisent un développement durable. La production de la recherche socio-économique sur la gestion d'un développement durable et la gestion de l'innovation dans un cadre concurrentiel. L'introduction d'un système de "crédits" pour les groupes sociétaux, qui leur permette, dans la mesure où ils collaborent, de subventionner des travaux de recherche.
- L'extension du rôle des experts socio-économiques pour qu'ils apportent leur soutien et leur vision à la RDT&I en relation avec les besoins sociaux.
- La formation des participants à des procédures multi-acteurs efficaces et à la facilitation des processus.

La démonstration et la diffusion de ces processus et de leurs résultats auprès des autres acteurs:

- L'évaluation et la définition d'un ensemble de mesures dans le domaine de la législation et de la fiscalité qui fasse en sorte que des alternatives techniques [par le canal de la R&D pour la technologie], soient examinées avant l'élaboration de projets de directive, etc.
- La R&D dans les sciences "dures" pour soutenir les domaines de dépenses publiques dont l'objectif est de promouvoir des solutions concurrentielles et durables.
- La recherche-action pour démontrer le fonctionnement des principes de futurs systèmes de production et du principe de participation.

- Des forums de mise en œuvre multi-acteurs pour la RDT&I et le développement durable combinés avec la compétitivité à des niveaux correspondant à certains systèmes socio-techniques spécifiques.
- La création de guides sur les bases de données et les ressources existantes en matière de bonnes pratiques des PME appliquant des approches concurrentielles de la "suffisance" [notamment pour les entreprises non insérées dans les réseaux existants].
- L'accompagnement socio-économique du processus de la recherche en RDT&I, avec une surveillance en temps réel, dans le but de présenter des défis, d'apprendre et de diffuser plutôt qu'une évaluation de la mise en œuvre des politiques.

13. **Ce cadre conceptuel doit être guidé par des principes tels que légèreté, flexibilité, durabilité, adaptabilité et circuit fermé de matériaux. Le cadre implique des processus reposant sur la collaboration en vue d'un apprentissage mutuel et d'une action. Ces principes et processus fournissent les éléments d'un "guide de conception pour la "suffisance"".**

14. Il existe des possibilités de coopération et de collaboration internationales cadrant avec cette approche. Par exemple :

- La coopération avec d'autres économies industrielles développées en ce qui concerne les grands défis mondiaux liés à l'émergence d'un développement industriel reposant sur la "suffisance".
- Le soutien concerté unilatéral ou multilatéral aux pays en développement de façon à intégrer les voies menant au développement reposant sur la "suffisance".
- La coopération avec les pays en développement et les économies en transition qui élaborent des solutions en fonction de leurs propres besoins et des circonstances qu'ils connaissent**.**
- L'engagement à la création de capacités nouvelles (capacity building) par la voie d'un transfert de connaissances et de compétences (surtout celles liées à l'intégration des systèmes et au développement de processus participatifs d'évaluation et de développement des technologies) en faveur des pays en développement.

ZUSAMMENFASSUNG

1. Dieser Bericht enthält strategische Leitlinien für künftige Strategien und Maßnahmen der EU zur Förderung der Forschung, technologischen Entwicklung und Innovation (FTEI) in der industriellen Produktion und den daran ausgerichteten Dienstleistungssektoren. Der Bericht zeigt, wie Forschung bis zum Jahr 2020 zu wettbewerbsfähigen und nachhaltigen Produktionssystemen in Europa beitragen kann.

2. Produktionssysteme sind von großer Bedeutung für Wirtschaft, Umwelt und Gesellschaft. Die Industrie steuert zur Zeit rund 20% zur europäischen Bruttowertschöpfung bei und beschäftigt etwa 30% der europäischen Arbeitskräfte - und erzeugt rund 25% des Abfalls, der Treibhausgase und des NO_2 in Europa.

3. Drei Themen bilden die Eckpfeiler des Berichts:

- Das europäische Produktionssystem ist nicht nachhaltig, und es ist bislang auch noch nicht hinreichend diskutiert worden, wie sich im Rahmen einer auf Nachhaltigkeit angelegten Wirtschaft Wettbewerbsfähigkeit und gleichzeitig eine akzeptable Lebensqualität sichern lassen.
- Die augenblickliche Entwicklung in der Modernisierung der Produktion kann durchaus eine Steigerung der Wettbewerbsfähigkeit und eine Verringerung der Umweltbelastungen mit sich bringen, dürfte aber kaum dazu führen, dass Produkte mit Blick auf Nachhaltigkeit hergestellt und verwendet werden.
- Die derzeitigen Strategien und Maßnahmen der EU zur Unterstützung der FTEI mögen zwar die ökologische Effizienz verbessern, werden aber nicht den Wandel in der Produktion bewirken, der notwendig ist, um innerhalb des Betrachtungszeitraums Wettbewerbsfähigkeit bei Nachhaltigkeit zu erreichen.

4. Die Expertengruppe hat für den Betrachtungszeitraum die Vision eines europäischen Produktionssystems entworfen, die Folgendes beinhaltet:

   Menschliche Erfindungsgabe [Wissen und Technologie], Kapital, Ressourcen und Bedürfnisse werden so genutzt und organisiert, dass die Menschen bei weniger Ressourcen- und Energieverbrauch ein besseres Leben führen können. Dies System ist nachhaltig, wenn Produktion und Konsum die Lebensqualität des Einzelnen und der Gesellschaft auf eine Weise fördern, die für die Wirtschaft von Erfolg ist und gleichzeitig die umweltbedingten und die Grenzen lokaler-globaler Kontexte respektiert.

5. **Diese Vision macht eine umfassendere Betrachtung des Innovationsgeschehens erforderlich. Dabei setzt die Expertengruppe den Akzent auf Suffizienz.** Der Bericht beschreibt in groben Zügen die Denkweise, die dieser Ausrichtung zugrunde liegt, verzichtet aber darauf, konkretere Strategien und Maßnahmen ausführlich darzulegen. Dies entspricht der Überzeugung, dass Innovationen von denjenigen entwickelt werden müssen, die ein bestimmtes Produktionssystem kennen, statt von der kleinen Expertengruppe, die sich im Laufe des Jahres 2000 in Brüssel getroffen hat. Als Hauptargument wird in dem Bericht angeführt, dass diese Ausrichtung auf Suffizienz die notwendige Voraussetzung darstellt für neue, auf die Bedürfnisse der verschiedenen Systeme zugeschnittene Strategien, Maßnahmen und Prozesse.

6. In einer umfassenderen, integrierenden Betrachtung des Innovationsgeschehens stellen sich Produktion und Konsum als Schlüsselelemente soziotechnischer Systeme dar. Soziotechnische Systeme umfassen in Gebrauch befindliche Technologien, Produkte und Werkstoffe sowie soziale Systeme. Beispiele soziotechnischer Systeme sind Information und Kommunikation, Mobilität oder auch die Bereitstellung von Haushaltsdienstleistungen wie das Reinigen von Kleidung oder die Ernährung. Innovation ist das Ergebnis einer Entwicklungstätigkeit, d.h. eines zielbewussten Änderungsprozesses, an dem viele beteiligt sind [Hersteller, Verbraucher und andere]. In diesem Prozess treffen wirtschaftliche, umweltrelevante, gesellschaftliche und wissenschaftliche Überlegungen zusammen. Unter dem Druck nationaler, europäischer und globaler Entwicklungen werden Lösungen erforderlich, die auf bestimmte soziotechnische Systeme und lokale Bedingungen zugeschnitten sind.

   Eine besondere Rolle spielt dabei die Art und Weise, wie die Globalisierung neue Achsen zur Steuerung technischer und gesellschaftlicher Innovationen schafft. Dies bedeutet, dass Innovationen in Zukunft Strategien folgen müssen, die auf die Bedingungen globaler Wettbewerbsfähigkeit und Innovation, von Umweltbelangen und gesellschaftlichen Bedürfnissen reagieren - und gleichzeitig staatliche Politik und Unternehmensstrategien durch Kooperation aufeinander abstimmen. Dies steht im Widerspruch zu den meisten derzeitigen FTEI-Strategien und -Praktiken und hat Auswirkungen auf den Kurs der Umwelt- und Industriepolitik wie auf die industrielle Praxis.

7. Die in diesem Bericht vorgestellte Betrachtungsweise stützt sich auf eine Reihe von Trends in der industriellen Produktion und nimmt einige bekannte, einfache Grundsätze auf. Beispielsweise werden Ressourcen in der Produktion immer effizienter eingesetzt, es gibt immer mehr Beispiele für Kreislauf-Produktion und die Hersteller gehen immer stärker auf die Ansprüche der Verbraucher hinsichtlich der eigentlichen Funktion und Leistung der Produkte ein. Eine enge Verbindung besteht auch zwischen der Erweiterung des Wissens und Innovationen als Grundlage der Wettbewerbsfähigkeit einerseits und einer ökologischen und sozialen Nachhaltigkeit andererseits. Diese Verbindung wird hergestellt über Konzepte lernender Organisationen sowie [gesellschaftlicher] Lernforen mit vielen Akteuren. All dies unterstreicht die Bedeutung kooperativer Verfahren zur Weiterentwicklung von Visionen, des Denkens in Systemen, der Problemfindung und Problemlösung sowie der Beseitigung von Hindernissen für einen Wandel.

8. Die aus diesem Prozess hervorgehenden Innovationen bewegen sich entweder innerhalb des gegebenen Kontextes oder sie durchbrechen ihn. Sie entsprechen einem von zwei Modellen - dem der Effizienz oder dem der Suffizienz. Effizienz ist ein lineares Konzept, das bei einer bestimmten Tätigkeit nach einem geringeren Input strebt. Bei der Suffizienz geht es um die Suche nach neuen Wegen, menschliche Bedürfnisse zu befriedigen. Suffizienz beschreibt die zur Befriedigung der Bedürfnisse erforderlichen Dienstleistungen und die Leistung materieller Produkte dafür. Suffizienz bedeutet beispielsweise, "Ausstattung mit Teppichen" zu verkaufen statt nur die Teppichware, Fotokopien statt Fotokopiergeräte zu liefern, saubere Kleidung oder kalte Lebensmittel statt Waschmaschinen oder Kühlschränke zu verkaufen. Bei Lösungen im Sinne der Suffizienz bleibt der Hersteller Eigentümer der materiellen Produkte und er verkauft seinen Kunden die Leistung dieser Produkte. **Nach Auffassung der Gruppe sollten die FTEI-Strategien und -Maßnahmen der EU auf der Basis der Suffizienz einen Bruch mit dem herkömmlichen Kontext unterstützen und**

fördern. Dies sollte ihrer Meinung nach bis zum Jahr 2020 im Mittelpunkt der FTEI-Strategien und Maßnahmen der EU stehen.

9. Eine kleine aber wachsende Zahl von Innovationen veranschaulicht das Modell der Suffizienz. Die Implementation dieser Innovationen stößt häufig auf institutionelle, organisatorische und verwaltungstechnische Hindernisse. Einige Hindernisse sind allgemeiner Art, andere beziehen sich auf die jeweilige Innovation oder das betreffende soziotechnische System. Die Entwicklung und Anwendung von Suffizienzlösungen erfordert es, diese Hindernisse als Teil des Innovationsprozesses zu begreifen und zu überwinden.

10. Hindernisse, die Suffizienzstrategien und kooperativen Prozessen, die das notwendige soziale Lernen ermöglichen, im Wege stehen, sind u.a.:

- unterschiedliche Managementstile und -kulturen in Europa [dieses Hindernis sollte jedoch nicht dadurch beseitigt werden, dass die Vielgestaltigkeit des europäischen Systems beschnitten wird, da Vielgestaltigkeit eine potentielle Innovationsquelle ist],
- unterschiedliche kulturelle und kommunikative Zugänge zu kooperativen Verfahren,
- fehlende Kohärenz und konterkarrierende Anreize des politischen Instrumentariums [z.B. stehen Steuern, Subventionen, Abschreibungen und Handelsvereinbarungen häufig im Widerspruch zueinander und fördern nicht die Suffizienz, zuweilen nicht einmal die ökonomische und ökologische Effizienz],
- geringe Beteiligung des privaten Sektors am politischen Entscheidungsprozess und schwach ausgeprägte Zusammenarbeit zwischen privatem Sektor und nichtstaatlichen Einrichtungen,
- relativ geringe Zusammenarbeit und Vernetzung in Forschung und Innovation,
- fehlende Initiativen, durch die potenzielle Partner über Sektoren und Interessen hinweg zusammengebracht werden könnten,
- Unfähigkeit der Verbrauchergruppen und anderer Akteure, sich wirksam in Lern- und Innovationsprogramme einzuklinken,
- Scheu vor dem Risiko, Ressourcen einzusetzen, um im Umfeld von Innovationen neue Formen organisatorischer Zusammenarbeit zu entwickeln,
- geringe Neigung der Unternehmen, lebenslanges Lernen auf allen Ebenen zu unterstützen,
- mangelnde Fähigkeit zum Denken in Systemen und zur Systemintegration,
- geringe Fähigkeiten, Interaktionsprozesse mit vielen Beteiligten, Fachrichtungen, Funktionen und Branchen zu moderieren und zu unterstützen,
- unzureichende Möglichkeiten, "best-practice"-Erfahrungen in der Organisation von Lernprozessen und Wissensteilung zu verbreiten,
- fortlaufende Verwechslung von Umweltmanagement und nachhaltiger Entwicklung.

11. Um den Übergang zu Suffizienzstrategien zu beschleunigen ist ein weitergreifendes und flexibleres Instrumentarium erforderlich, als bei der derzeitigen Unterstützung von FuE-Verbundprojekten eingesetzt wird, beispielsweise

- eine 100%ige Finanzierung von Forschungsvorhaben, die zentrale soziotechnische Systeme identifizieren und Ideen für Suffizienzlösungen generieren, die materiellen Konsum durch nachhaltige Dienstleistung reduzieren,

- finanzielle Unterstützung einer Neugestaltung der FuE-Infrastruktur und des Innovationssystems, die den neuen Wissensbedarf, den neuen Kontext für den Dialog mit der Industrie sowie den Bedarf an neuen Fähigkeiten und Kompetenzen widerspiegelt,
- ein wichtiges neues Element der Innovationsinfrastruktur sind internationale Kompetenznetzwerke als Grundlage für die Forschung und die Verbreitung der Forschungsergebnisse. Diese Netze sollten für [maximal] 5-10 Jahre eingerichtet werden, über ein [relativ] gleichbleibendes Budget verfügen und Kommunikation als eine zentrale Aufgabe haben. Sie sollten in einem breit angelegten, europaweiten Kommunikations- und Kooperationsnetz die Knotenpunkte bilden,
- Umstrukturierung der Forschungsbürokratien so, dass sie die partizipativen Prozesse, die angestossen und gefördert werden sollen, auch selbst widerspiegeln - d.h. die Forschungsbürokratie sollte interdisziplinär sein, auf Partizipation und Erfahrung gründen, und für eine kontinuierliche Interaktion mit EU-Experten und geförderten Einrichtungen offen stehen. Dies könnte auch Experimente mit einer kontinuierlichen Prozessevaluierung und sich daraus ergebende Interventionen in Projekte einschliessen.

12. **Angesichts der Unzulänglichkeiten des derzeitigen FTEI-Systems und der Hindernisse für eine Politik der Suffizienz in Europa wird ein "strategischer Rahmen" für sechs gleichzeitig ablaufenden Forschungsprogrammen vorgeschlagen:**

Entwicklung von Ideen für innovative Ansätze für Suffizienzstrategien in ausgewählten soziotechnischen Systemen:

- Prospektivforen, auf denen gesellschaftliche Gruppen neue Ideen entwickeln und Erfahrungen sammeln und austauschen über die Erwartungen relevanter Akteure hinsichtlich einer "nachhaltigen" Wettbewerbsfähigkeit,
- größtmögliche Förderung von FTEI-Projekten von Außenseitern und Querdenkern durch eine kontinuierliche Ausschreibung unter dem Thema 'Wettbewerbsfähige und Nachhaltige Entwicklung',
- Sondermittel für Innovationen, die interessante Resultate versprechen, aber nicht die herkömmlichen Kriterien erfüllen.

Ein besseres Verständnis soziotechnischer Systeme:

- Organisation partizipativer Foren, um die Schlüsselakteure spezieller soziotechnischer Systeme zu etablieren, und um festzustellen, welches die besonderen Merkmale dieser Systeme sind und welche Bedürfnisse und Interessen darin wirksam werden,
- Festlegung einer "Geschäftsgrundlage" für Beiträge der Beteiligten zu kooperativen Aktionen.

Überwindung der Hindernisse für einen Wandel und Nachweis der Realisierbarkeit von Lösungen

- Bewältigung von Problemen beim Wissenstransfer und organisatorischer Hindernisse für Unternehmen, die Suffizienzstrategien verfolgen wollen,
- Entwicklung von Methoden der Kostenrechnung und Finanzkontrolle, die die wirklichen ökonomischen Aspekte der materiellen Einsparungen und materiellen Werte widerspiegeln, die durch produktbezogene Dienstleistungssysteme erzielt werden können,
- Programme zur Förderung von Kompetenzen zur Entwicklung von "Dienst-Leistungen" statt zur Erzeugung von Produkten, so dass Produktionsarbeiter Dienstleister werden können,

- Unterstützung zwischenbetrieblicher Zusammenarbeit mit Hilfe von Informationstechnologie, Wissensmanagement und Logistik, vor allem bei reversen Lieferketten und Rücknahmesystemen,
- Feststellung und Beseitigung von Hindernissen, Risikokapital für wettbewerbsfähige und nachhaltige Entwicklungsprojekte bereitzustellen,
- Festlegung eines Katalogs politischer Strategien zur Förderung der Suffizienz in bestimmten soziotechnischen Systemen.

Unterstützung für die Entwicklung und Übernahme wichtiger Querschnittstechnologien:

- Akzentuierung von Grundlagenforschung zu Technologien, die eine Dezentralisierung von Systemen ermöglichen. Im Mittelpunkt stehen die Informations- und Kommunikationstechnologie, die Biotechnologie sowie die Mikro- und Nanotechnologie. Dies sind wichtige Querschnittstechnologien für die Materialreduzierung und die Ressourcenproduktivität.

Aktivierung verschiedener Betroffener/Betroffenengruppen für Lern- und Änderungsprozesse:

- Einbindung gesellschaftlicher und ökologischer Gruppen zusammen mit Unternehmern in die Programmausschüsse des Rahmenprogramms,
- Erweiterung der Wissensgrundlagen über nachhaltige Innovationsmechanismen in der Fertigungspraxis; sozioökonomische Forschung über Nachhaltigkeits- und Innovations-management unter Wettbewerbsbedingungen; Einführung von Gutscheinen für gesellschaftliche Gruppen, die es ihnen gestatten, relevante Forschungsarbeiten gezielt zu bezuschussen,
- verstärkter Beitrag sozioökonomischer Experten zu Forschungsarbeiten oder als input für Visionen über zukünftige soziale Bedürfnisse,
- Schulung von Betroffenen, um Multi-Akteurs-Prozesse organisieren und moderieren zu können.

Demonstration und Verbreitung dieser Prozesse und ihrer Ergebnisse:

- Entwicklung eines Katalogs von Strategien, um noch vor dem Entwurf von Gesetzen, Richtlinien, Besteuerungsregeln usw. technische Alternativen prüfen zu können,
- FuE in den Naturwissenschaften, um die öffentliche (Ausgaben-) Politik dort zu unterstützen, wo es um wettbewerbsfähige und nachhaltige Lösungen geht,
- Aktionsforschung, um die Prinzipien zukünftiger Produktionssysteme und partizipativer Prozesse in Aktion zu entwickeln und zu demonstrieren,
- öffentliche Foren, um auf Nachhaltigkeit und Wettbewerbsfähigkeit ausgerichtete FTEI-Prozesse auf den geeigneten Ebenen einzelner soziotechnischer Systeme in Gang zu bringen,
- Aufbau von Datenbanken und Leitfäden für eine "gute Praxis" in kleinen und mittleren Unternehmen (KMU), die an wettbewerbsfähigen Konzepten für die Suffizienz interessiert sind [insbesondere für Unternehmen, die nicht in die bestehenden Netze eingebunden sind],
- Sozioökonomische Begleitung der Forschungsprozesse mit dem Ziel, statt herkömmlicher Evaluation Herausforderungen aufzuzeigen, aus den laufenden Forschungsprozessen zu lernen und ihre Resultate zu verbreiten.

13. **Für diesen Entwicklungsrahmen sollten bestimmte Prinzipien gelten wie Einfachheit, Flexibilität, Beständigkeit, Anpassungsfähigkeit und Werkstoffkreisläufe. Der Rahmen**

umfasst Prozesse, die auf Zusammenarbeit für gemeinsames Lernen und Handeln aufbauen. Diese Grundsätze und Verfahren sind Bestandteil eines 'Entwicklungsleitfadens für Suffizienz'.

14. Im Rahmen des hier beschriebenen Ansatzes gibt es vielfältige Möglichkeiten für internationale Zusammenarbeit, z.B.:

- Zusammenarbeit mit anderen Industrieländern bei zentralen globalen Herausforderungen für eine industrielle Entwicklung auf der Basis der Suffizienz,
- abgestimmte bi- oder multilaterale Unterstützung der Entwicklungsländer, um ihnen die Wege zu einer auf Suffizienz basierenden Entwicklung zu erleichtern,
- Zusammenarbeit mit Entwicklungsländern und Transformationsländern, die Lösungen auf ihre besonderen Umstände hin zuzuschneiden versuchen,
- Engagement für die Entwicklung von Transferkompetenzen, insbesondere soweit sie sich auf die Systemintegration und die Entwicklung besserer Verfahren für eine partizipative Technologieentwicklung und Technologiefolgenabschätzung in Entwicklungsländern beziehen.

1. TASK AND CONTEXT

This report contains the views of the expert group on competitive and sustainable production systems in Europe. It provides the European Commission with advice on EU policies and actions to support research, technology development and innovation (RTD&I) in production and related service industry sectors that will contribute to competitive and sustainable production in Europe during the period to 2020.

Three cornerstone issues frame the report:

- The European system of production is not sustainable and has not begun to address in a substantive way how competitiveness can be achieved within the framework of sustainability.
- Current trends in the modernisation of production have the potential to improve competitiveness and to reduce environmental impacts but are unlikely to bring production, and the use of products, within the framework of sustainability.
- Present EU policies and actions for RTD&I might improve environmental performance but will not foster the transformations in production that are required to achieve competitiveness within the framework of sustainability during the prospective period.

Securing a competitive and sustainable production system requires transformative change in research and technology development and the European innovation system. The EU can contribute to this transformation through policies and actions for RTD&I that encourage a more integrated arena for innovation and a focus on the notion of sufficiency. The report sets out the rationale for this change and presents arguments for this orientation for EU RTD&I policies and actions.

2. INTRODUCTION AND BACKGROUND

Technology assumes a central role in human development. Many human needs are met through its application. Technology is used to make things, it is found in products in material form, and, in the asset we call 'know how'. It contributes to our expectations about life-style and patterns of consumption. Indeed, the conditions that lead to our present [unsustainable] culture of consumption are strongly influenced by technologies that support modern communications, media and fashion.

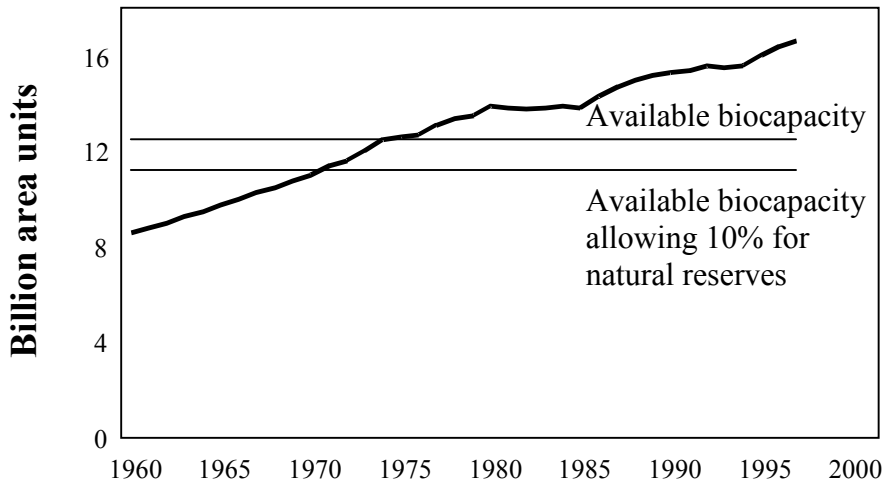
A complex process of technological innovation leads to the satisfaction of human needs. In this process human ingenuity, from science and research, is combined with managerial and organisational capabilities to provide a basis for economic prosperity and the competitiveness of firms and nations. Successful innovation also depends on demand. Technology is created through adoption by demanding consumers. The choice to purchase and use a technology is therefore a critical aspect of innovation.

Technological innovation arises in 'innovation systems', formed around long-standing institutional structures and interactions between, science, industry, education and government and other actors. Among other things these interactions provide the basis for capabilities in science and research, and, in business. Innovation systems differ between nations and regions, with industries connected to these systems in highly specific ways. These differences lead to variations in the innovation and competitive performance of firms, industrial sectors and nations.

Technological innovation determines the state of economic development and it also places stress on the resource endowments and services of the natural and physical world. Concern about the degradation of environmental resources and services has led to demands for better environmental management and protection and to calls for more sustainable forms of development [Agenda 21, 1992; Brundtland, 1987].

The pressure for sustainable development arises from the way we live – how we produce and how we consume. These pressures will increase as living standards and expectations rise in developed and developing countries, and with anticipated growth in global population. The extent of the demands of development on the biocapacity of the planet is shown in Diagram 2.1.

Diag. 2.1 World Ecological Footprint 1961-1997



Source: Living Planet Report 2000 WWF

In response to these pressures sustainable development (SD) was put on the global political map by the UN Summits held in Rio de Janeiro in1992 and Kyoto in 1997. The EU is among those committed to draw up SD strategies for the Rio+10 Summit in 2002. The Amsterdam treaty makes SD one of the core tasks of the EU and the Heads of State and Government asked the European Commission at Helsinki in 1999 to elaborate a European SD strategy and submit it to the Göteborg European Council in June 2001. The text of the EU Communication fulfils this task, while the Stockholm conference "Bridging the Gap" in May 2001 established bridges between science and the environment.

Furthermore, the European Commission has progressively been integrating sustainability within its operations. For instance, the "Competitive and Sustainable Growth" R&D programme, focuses on industrial technologies, taking into account environmental and social impacts in the evaluation of the R&D projects, together with economic competitiveness. In the case of environmental management, the voluntary Eco-Management and Audit Scheme [EMAS] was introduced in 1993, and aims to improve the environmental effects of business through voluntary commitments (by industrial sites as well as other sectors of economic activity). Sustainability is being integrated in the activity of all relevant Directorate Generals (DGs), while the European Climate Change Programme (ECCP) is another significant EU action involving the participation of several DGs.

3. AN INTEGRATED ARENA FOR INNOVATION

The point of departure for this report is that competitive and sustainable production can only be achieved if innovation arises out of a more integrated arena. This reorientation of research, technology and innovation reflects the fact that technologies do not exist in isolation. Technologies connect to other technologies [for example, technologies are used to make products, technologies are found in products and technologies are combined in use]. These 'technological sets' are embedded in socio-technical systems, which span the activities of production and consumption. Socio-technical systems, in turn, involve networks of actors, many of whom depend on the technologies in the system for their economic position or status. Interdependencies between actors and between actors and technologies create rigidities and obstacles that constrain technological and social innovation.

If production is to contribute to economic growth, social development and quality of life, while respecting environmental limits then it is necessary to foster innovations that de-couple the environmental impacts of products from their functional performance and value-added. At present there is no well-known route to meet this challenge. What we do know is that any route must contend with complexities, paradoxes, uncertainties, vested interests and other obstacles.

de-coupling the functional performance and value-added by material products from their environmental impacts

We also know that innovation is a form of experimentation. These experiments should be based on sound science. They involve the careful development of creative human processes and should yield a range of possibilities that are taken up by the market. Complex transformations of socio-technical systems require open processes and platforms, through which actors can share information, develop knowledge and identify ways to work together.

Box 3.1. Technologies, Socio-technical Systems, Actor Networks and Innovation Systems

The microprocessor provides an illustration of the connection between technology, socio-technical systems and actor networks. Microprocessors are linked to other technologies provide the basis for the 'technology set' that is information and computing. These are part of the socio-technical system of information, communication and computing that includes *inter alia*: hardware and software, the cable and fibre optic networks, telecommunications satellites, Internet and so on. The network of actors in this system ranges from designers and engineers, business strategists, financiers and policy makers and users. The socio-technical system is, in turn, embedded in the innovation system. Re-designing this socio-technical system for sustainability and competitiveness requires the active involvement of many of the actors who make up the system. It demands careful and potentially far-reaching technological, organisational, institutional and social change.

Policies and actions for RTD&I have an important role in supporting and guiding these processes and the choice between a range of economic, social and environmental futures, including futures that are more competitive and sustainable. This is an inspiring challenge as society and industry value innovation highly. And competitively produced goods that are sustainable are seen as an outcome of good management.

….competitively produced goods** that are **sustainable** are seen an outcome of **good management

Competitive and sustainable production arises in an arena formed by the fabric of choices made by institutional agents [governments and NGOs], market actors [households, enterprises] in the context of a mix of policy instruments [laws, regulations, taxes, incentives, trade agreements], processes [private/public partnerships, direct social participation] and innovations [academic, training, research institutions, knowledge transfers].

3.1. The Expert Group

Members of the expert group drew on their knowledge of competitive and sustainable production and the role of research and technology gained as practitioners and academics, and, advisors to industry and governments in Europe and beyond. The members of the group were united behind some key assumptions:

- The European economy creates pressures that exceed environmental limits or carrying capacity despite continuing efforts to protect the environment [WWF, 2000; World Watch Institute].
- European production is not competitive and sustainable despite efforts by many enterprises to improve their competitiveness and reduce their negative impacts through new approaches to environmental management, and, notwithstanding, the general level of public consciousness of these issues.
- Trends in the modernisation of manufacturing and business support the possibility of more competitive and sustainable production and consumption systems – for example: eco-efficiency and miniaturisation.
- There are some simple principles, which if adopted more widely, would support the move toward more competitive and sustainable productions systems.
- There are strong links between the processes that contribute to the development of knowledge and innovation, the foundation for competitiveness, and, environmental and social sustainability.
- Breakthrough innovations required for sustainability go beyond more efficient production processes and products to develop solutions to production and consumption that adopt the thinking of sufficiency (see examples in Appendix 1).

3.2. A Vision

With these assumptions in mind the expert group developed a vision of a European system of production in which:

> *Human ingenuity [knowledge and technology], capital, resources and needs are harnessed and governed so people can live better lives while consuming less material resources and energy. This system is sustainable when production and consumption support the quality of*

individual and social life, in ways that are economically successful while respecting environmental limits within the changing context of local-global conditions.

4. ANALYSIS

4.1. The Importance of Manufacturing and Production to European Competitiveness and Sustainability

Manufacturing products is important in Europe and globally. The OECD identifies that, in 1998, manufacturing accounted for about 20.7% of the gross value added in the EU [down from 23.6% in 1988]. In the same period manufacturing output rose 13% in the EU. Manufacturing employs just under 30% of the European workforce. Examples of the impact of European industry and manufacturing on the environment include industry's contribution of 26% of NO_2, 23% of green house gas emissions. Manufacturing contributed 26% of waste generated in EU Member States [Environment in the European Union at the Turn of the Century: European Environmental Agency 1999: European Environment Agency; Copenhagen].

These environmental burdens should be viewed with care as they only describe the direct environmental effects of manufacturing processes and industrial activity. Present statistics separate the environmental burdens of winning primary resources, such as material extraction and energy, from the burdens of production processes and the consumption activities of households. In practice the true burden of manufactured products includes the direct effects arising from manufacturing processes, the material and energy contained in products, distribution and packaging, and the energy and material requirements from the use, disposal or re-use of products and their material elements. The implication is that 'products in use', or 'materials in use' have major impacts on the competitiveness and sustainability of the EU and its Member States.

4.2. The Characteristics of Sustainable Development and Sustainable Production

Sustainable production is a key component of sustainable development, with its environmental, social and economic dimensions. Sustainable development should not be confused with environmental management. Environmental management invariably seeks improvements in performance without reference to environmental limits, whereas, sustainable development fosters human activities

Sustainable production is a key component of sustainable development with its environmental, social and economic dimensions.

within the carrying capacity or environmental limits of the planet, now and in the future, at all scales from local to global. Moreover, sustainable development has a social dimension, paying attention to the quality of life, defined by factors such as the quality of work and social cohesion.

A number of characteristics must be satisfied in order to ensure that production processes and the use of products and materials operate within environmental limits. These are:

- The sustainable use of renewable resources and renewable energy;
- The management of non-renewable resources, for example in closed material loop systems;
- The use of non-renewable energy in ways that maintain the integrity of natural cycles, such as the carbon cycle;
- The maintenance or restoration of ecological and environmental systems that provide environmental sinks for wastes and pollution arising from production, products and materials in use and waste;
- The minimisation of transportation needs.

These systems should:

- Operate in a competitive market framework;
- Provide for social cohesion and quality of life, implying a satisfaction of human needs extended to all members of the population.

Sustainable production is context dependent. It is defined and interpreted by different societies in line with:

- Economic trends, such as those related to growth and to market and pricing mechanisms, that may change ecological balances, social cohesion and determinants of economic welfare;
- Socio-cultural trends changing the requirements for human satisfaction, including new life-styles or society's ecological concerns;
- Political trends and priorities modifying the regulatory process that deal with management of the environment, the economy and society.
- Ecological conditions and environmental limits;
- Our knowledge of those circumstances and limits;
- International issues including the economic and physical transfer of materials, energy and products across boundaries, resources

4.3. International Context of Competitive and Sustainable Production

Competitive and sustainable production systems must be considered in the light of international as well as local issues. There are important international dimensions of sustainability, markets and innovation, which provide a dynamic and complex context. These raise issues about the

governance of innovation and the role of science and research in society. These issues are addressed in this section.

4.3.1. International Dimensions of Sustainability

Sustainable development is a response to three types of problem, which directly or indirectly affect the EU and its Member States. They are:

- problems of **affluence**: the environmental consequences of industrialisation that accompany the resource throughputs, energy demands, pollution and waste generated by developed economies and the life-styles of their citizens**.**
- problems of **transition**: the environmental and social problems arising from the process of economic development in rapidly industrialising countries and those which have undergone recent transition from central planning to market-based systems. These relate to the environmental burdens of industrial activity against a backdrop of poorly enforced systems of environmental and resource planning and control.
- problems of **poverty** and **population**: problems invoked by the environmental, social and economic issues of underdevelopment linked to increases in population levels, which centre on the access by the poorest of the poor to basic resources. Added to this environmental degradation is becoming a major source of rural poverty in many countries.

Sustainable development**, involves **re-learning our approach to development** and is a **continuous process of experimentation

Problems of affluence arise from the patterns of production and consumption established within the EU and its Member States. Problems of transition are found in many of the accession countries that await enlargement of the EU. Problems of poverty and population are found in pockets of the EU and neighbouring states, and a number of countries with which the EU trades, around the globe. Many of the poor in accession states and non-EU countries view the comparative economic success and political stability of the EU as a refuge from their own economic and/or political circumstances. Addressing all three dimensions of sustainable development is important for the wider environmental, social and political security of the EU and the prosperity and well being of all EU citizens.

4.3.2. Globalisation of Markets and Innovation

Globalisation of markets affects competitiveness and sustainability. Markets, as the arena for product offerings, are increasingly open and global. The competitiveness of EU producers is increasingly judged by global standards, and, stock markets, which establish expectations for company performance, in terms of innovation and competitiveness, are becoming seamless.

Globalisation also impacts the innovation system of nations. Countries with successful systems of innovation must now take account of the international dimension of knowledge creation and technological innovation. Keeping apace with these issues is part of the overall process of industrial modernisation. It requires an international outlook to be meshed with the strengths of existing national and European innovation systems. This requires support from national and EU institutions.

The 'globalised' world is creating a new axis for the governance of science and technological innovation. In the past, governance was seen in terms of local, nation state, regional [EU] and global levels. The division of responsibilities for policy and practice between these levels was managed through the principle of subsidiarity, with responsibility passed to the lowest operationally practical level. However, subsidiarity, applies less well in the emerging fragmented yet global society, with its multi-local, and local-to-global axes. New connections are needed and new relationships between governments, private sector and civil society. This is particularly important for companies with global span and local operations, as global technologies ought to be utilised in culturally and locality specific ways. For example, the problems the US company Monsanto experienced with gaining acceptance for its GMO technologies could be described as a conflict between local/regional expectations and the company's global strategy. Monsanto's global strategy simply did not anticipate that different world regions would react differently to the applications of this technology.

The local/global axis of the governance of innovation is important for other reasons. The group's entire project is about the EU's role in RTD&I vis-à-vis nation states and decentralised RTD&I actors. A particular area of concern then is the adequacy of the managerial skills and organisational capabilities to ensure the necessary linkages between local concerns and global pressures and to establish better global/regional to local and local to local connections. Technology and infrastructure networks are important but, so too, are the managerial capabilities that recognise the differences between local conditions and can tailor technological solutions to local needs.

Moreover, the increasingly global structure of manufacturing and trade contradicts the closed material and product loops required for sustainability [see Section 4.2. and the examples given in

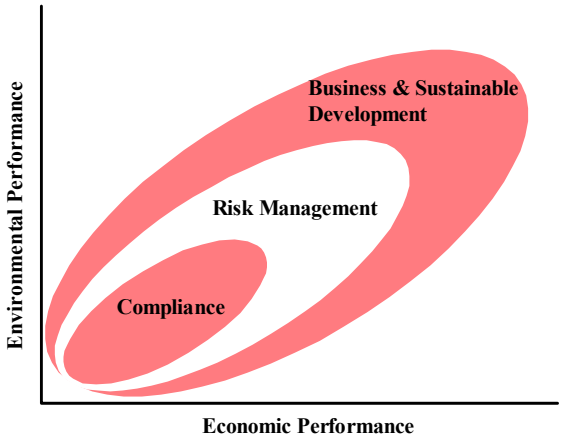
Appendix 1]. It is not clear whether localised, closed loop systems of production and consumption have competitive advantage over global production chains. However, Europe seems to lag behind in the implementation of these approaches, which minimise transport costs and impacts, maximise materials recovery and retain wealth acquired through added value in national and local industrial clusters.

5. LINKING COMPETITIVENESS AND SUSTAINABILITY IN BUSINESS

Competitiveness is a pillar of sustainable production. However, competitiveness and environmental performance have traditionally been viewed in terms of trade-offs. The logic here is that environmental improvements [internalising the externalities of production] are only achievable at a cost to competitiveness. Policy making by governments has focused on striking an acceptable balance between interests - industry, employees, consumers and citizens, and social interests in environmental quality and quantity. However, this logic really applies to remedial responses to productions systems that were not designed with environmental impacts or limits in mind. This report does not focus on trade-offs; it seeks innovations that are synergistic.

Competitiveness** is a **pillar of sustainable production.

Synergistic innovations are possible because of trends in manufacturing and business. Together with growing environmental awareness, these are changing the way people think about business. While many companies are still only concerned about environmental compliance, an increasing number are adopting approaches to environmental risk management. Other companies are beginning to pursue long-term sustainable development strategies.



There is a detectable hierarchy of approaches to environmental management and sustainable production in business. This is shown in Box 5.1.

Trends in the modernisation of production support movement through the hierarchy, especially the levels beyond pollution control and compliance. For example, lean production,

miniaturisation, advances in the durability of materials, and, lower energy inputs in the manufacture of products are leading to efficiencies. Consequently, products are less material intensive. These gains in resource efficiency support competitiveness and reduce the environmental impact of production processes and products. The outcome is that the environmental burden, of each unit of product, is lowered.

Box 5.1. - A Hierarchy from Environmental Management to Sustainable Production

A hierarchy of approaches to environmental management and sustainable production moves from:

Pollution control and compliance – end of pipe approaches
Eco-efficiency – process optimisation [waste minimisation, yield maximisation]
Eco-design – product optimisation, design for recyclability, etc.
More integrated environment and business processes – e.g. relating health, safety, environment, quality, strategy
Sustainable production – sufficiency through extended product service solutions and performance that links production and consumption.

Each stage in the hierarchy has merit. The hierarchy is not a continuum. Important antecedents enable movement through the hierarchy such as commitments to quality, organisational learning and collaboration. A production organisation committed to sustainable production engages in unlearning as well as learning. Sustainability is possible only when most of production moves to the end of the hierarchy.

Beyond these trends in production some businesses are making organisational commitments to more pro-active, strategic positions on environmental management. For example, by introducing environmental management systems, which integrate with their business processes, or by applying principles of pollution prevention and design for environment to their processes and product development. However, modernisation of production and organisational commitments to environmental management are not sufficient to bring about sustainability, as there are important rebound effects. These arise as gains in resource productivity and competitiveness reduce the real cost of products and increase the offerings available to consumers. More consumers are then able to purchase more products. While environmental and economic [eco-]efficiency is desirable, so-called win-win positions, invariably accept the context within which products are offered.

Sustainability requires more profound innovation. The route here is context breaking, based on innovations that lead to new ways of providing for human needs and the generation of market opportunities. A number of companies recognise that sustainability strategies offer new opportunities as managers try to be competitive within environmental limits and social constraints. These emerging strategies involve collaborative approaches to knowledge

development, organisational learning and joint action. They emphasise the development of scenarios, agreement on preferred solutions, and the use of back-casting techniques coupled to technology assessments using environmental, social and economic analyses of the expected performance of the innovations that are identified. They involve commitments to ideas such as zero emission and zero waste, achieved through pollution prevention and design for environment protocols. Closed material loop systems are adopted for products designed for dismantling and for durability. These are supported by new systems of reverse logistics and material recovery.

- ***Context-taking seeks sustainable development*** *through* ***win-win-win situations.***
- ***Another approach is context breaking****, is to be found* ***in innovation*** *that leads away from the limits that define* ***win–lose combinations*** *to create* ***completely new markets***

The carpet suppliers Interface and Collins & Aikman, which started to sell flooring services rather than carpets, provide illustrations of this type of thinking. Electrolux is also developing a 'smart home' venture with a power utility. This involves families paying for clean clothes services rather than buying washing machines. In these systems industrial and final consumers, together with other actors, accept new ways of acting, new technologies, and the responsibilities that go with their use.

New orientations in manufacturing support this approach. For example, the traditional focus on products is being replaced by the concept of product services [see Box 5.2.]. In this view, human needs are met through performance of products rather than the product itself. Product-services mean it is no longer necessary to sell customers products, which they then own.

Box 5.2. - Product Service Example – Clean Clothes Services from Electrolux

The logic of selling a washing machine to customers who then become responsible for their maintenance, use and disposal is fundamentally different to that of selling clean clothes services. Clean clothes service providers retain ownership of the machine, incorporate its maintenance costs, the loss of value of material components during the life-time of the machine and the costs and value of the machine at the end of its useful life into their cost structure. They are concerned to reduce these costs by designing the product for durability, ease of repair, reuse of materials or modularity so that components can be replaced progressively as they become obsolete or through changes in taste. These closed loop product and material cycles focus attention on forward and reverse logistics with their associated supply and material [asset] recovery chains.

If needs are met through the performance provided by products then it is possible for manufacturers to retain ownership of the material locked in their products and to sell performance to the consumer. When manufacturers retain ownership of the material content of products they assume a 'material stewardship philosophy' becoming more concerned about the durability and maintenance costs of products, and, managing the asset value of materials locked in products. Consumers become more concerned about the services and performance that meet their needs and the costs of supporting those needs. This approach places new demands on human and organisational capabilities available to producers.

The design challenge for manufacturers is to understand better the service performance of products, customer requirements and environmental impacts. The challenge for business is to find competitive solutions within environmental limits and in a socially responsible manner. The challenge for innovation systems is to create the platforms that enable new product service systems to be designed and implemented through the active participation of the many key actors.

5.1. Building Innovation for Competitiveness and Sustainability

Diagrams 5.1 & 5.2 show schematically dimensions of the production sector's contribution to innovation that is competitive and sustainable. It suggests a process that:

- involves many actors in choosing technological options and socio-technical solutions,
- adopts a long-term orientation that avoids irreversibilities caused by solution lock-in, reducing the burden of distribution and recovery of materials through the design of processes, supply chains and value networks.

It involves assessments of:

- economic, environmental and social impacts over the life-cycle of the innovation and system,
- efficiency in the use of resources in relation to value added through products,
- links between technologies and systems change.

The product/service/social innovations emerging from this process are likely to be:

- **light**, in terms of resource intensities and productivity,
- **flexible**, in terms of use and multi-functionality [multi-valency],
- **durable**, **adaptive**, and **focused on performance** [in the sense that performance is more important than material product, and includes the liabilities of performance].

These dimensions must fit within a process, as all are the dimensions have to be met for solutions that are competitive and sustainable.

Diagram 5.1: Demand Side

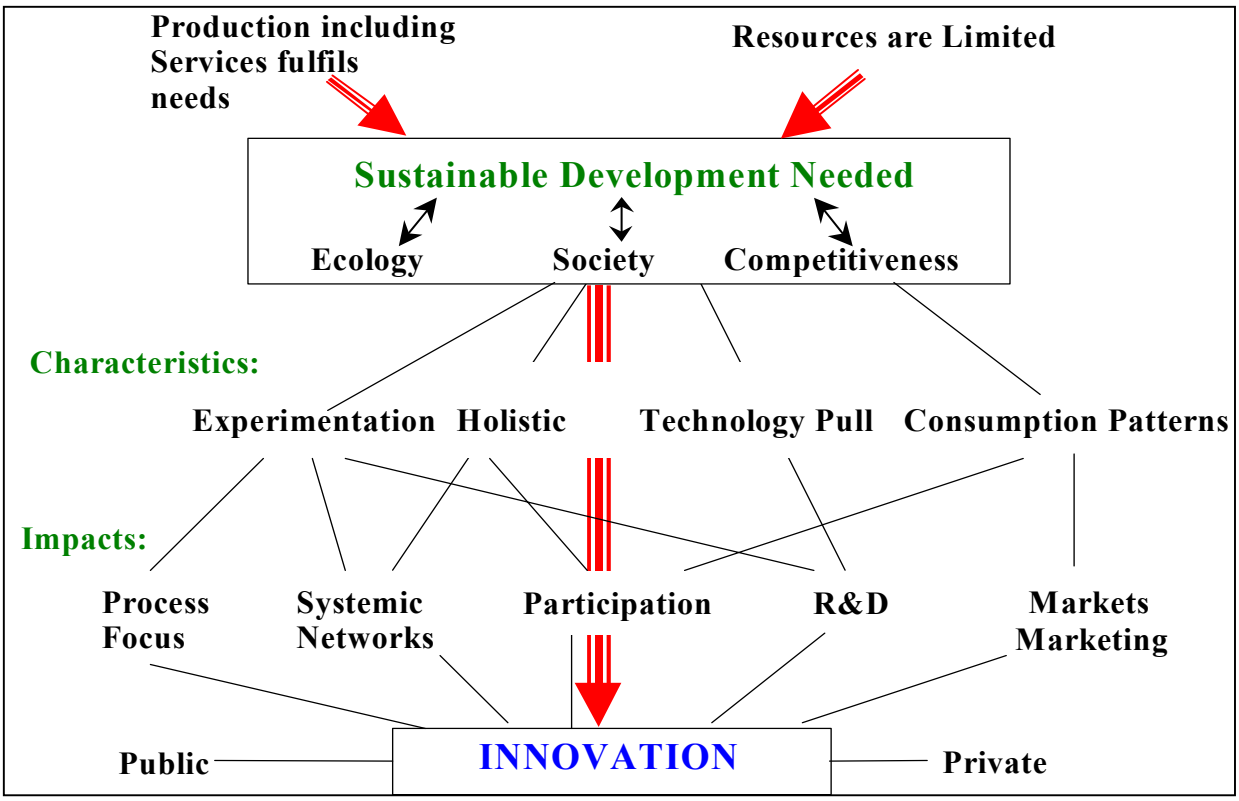
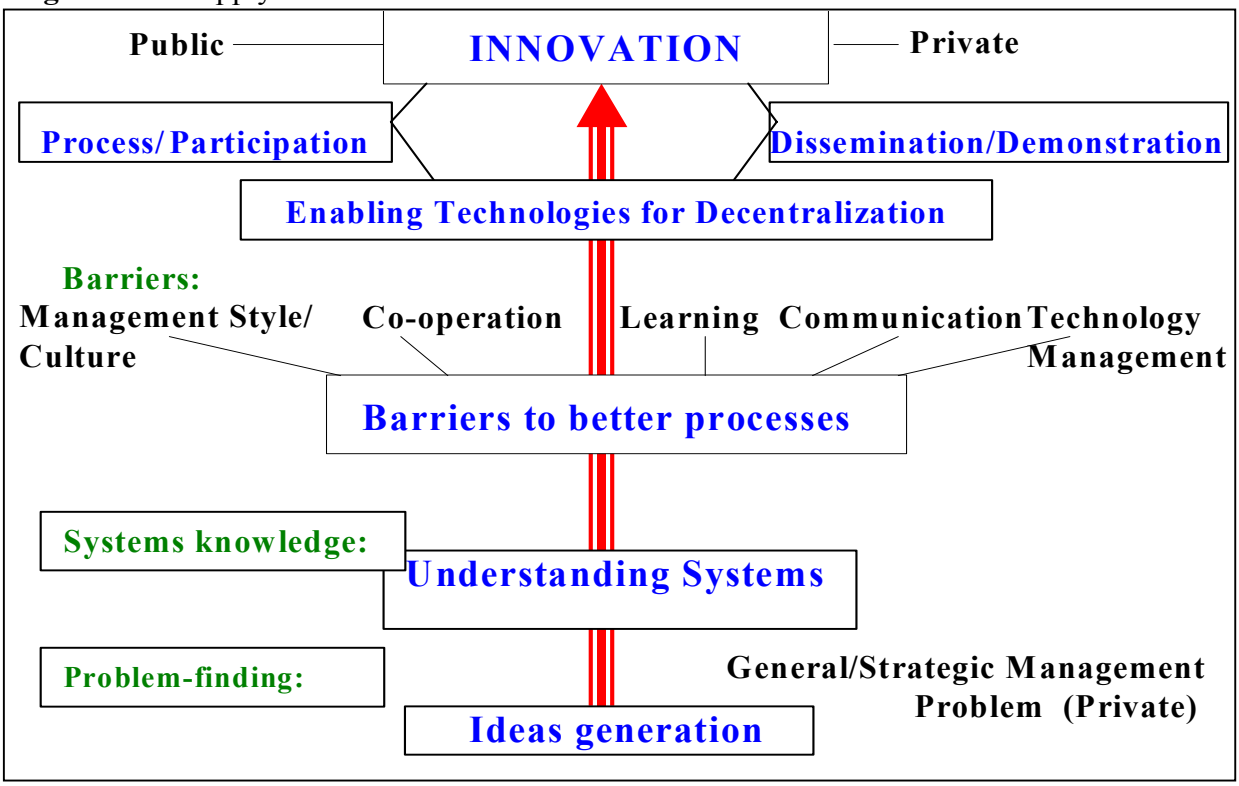


Diagram 5.2: Supply Side



5.2. A Way Forward for Manufacturing and Production

Production in Europe and globally is adopting two archetypes – efficiency and sufficiency. The characteristics of these archetypes are:

- Traditional **efficiency strategies** involve the modernisation of material throughput in linear industrial systems [which the reader might view as similar to managing the flow of a river]. Modernisation involves manufacturers in optimising production processes up to the point of sale and the redesign of products. For example, manufacturing processes are controlled for raw material utilisation, process regularity, and optimal operational performance. Products have high of known quality and minimum of variations. Gains in environmental impact arise from the reduction of waste, elimination of pollution and through R&D that reduces or eliminates hazardous and polluting substances, miniaturises product components or reduces weight. Environmental modernisation is supported by emerging concepts e.g. eco-efficiency, factor 4/10, material recycling, and product stewardship.

  Modernisation strategies have an important role in more radical changes taking place in how we think about production. Modernisation is revising our concepts of production and consumption, recycling and waste treatment. It draws environmental management techniques, such as life-cycle analysis. This approach is strongly influenced by hard sciences, such as the material and life sciences.

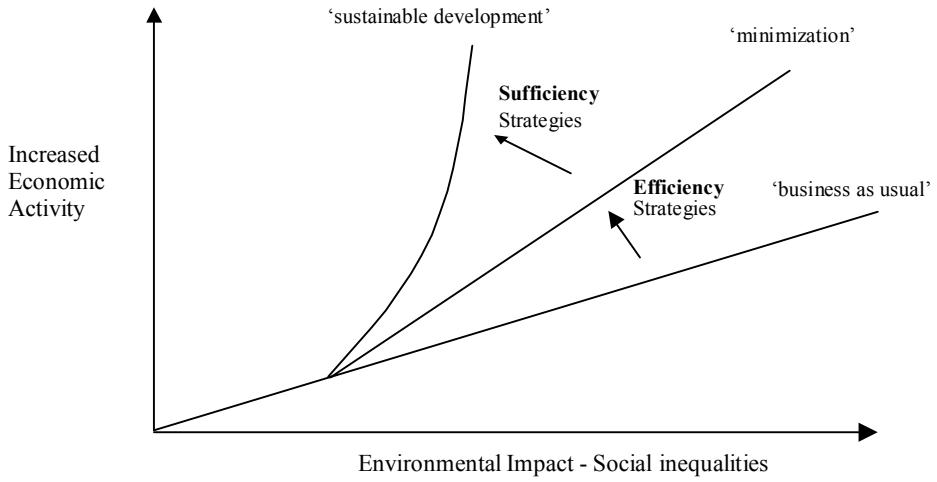
- Emerging, context breaking manufacturing strategies are based on the sale of performance and use. **Sufficiency strategies** correspond to a circular or loop economy [which the reader might view as similar to managing the level a lake]. They focus producers on the sale of performance and optimisation of extended producer responsibilities. Emphasis on performance and the sale of utilisation value creates demand for competence in managing the value of the assets retained in material products. It shifts focus from production to production and consumption. Here life-cycle analysis involves economic, social and environmental assessments. It encourages a preventative engineering approach in which technical systems are designed for continued operation in the case of component failure - this includes resilience and redundancy.

  Technologies are required but so too are innovations in networks of actors, marketing and new ways of providing performance with others, instead of just selling products. New relationships and arrangements between actors within the system have to be established and maintained together with new technological configurations. New equipment and production methods are required, while consumers need to change their routines and life-styles [for example - leasing/renting rather than buying and owning material products]. Equipment becomes more modern [competitive] as a way to attract consumers, but, there is a need to promote modular system design and standardisation of components, closed material loop manufacture and redistribution logistics, in order to avoid rebound effects from shorter product life-times. The approach is strongly determined by soft skills as well as hard sciences.

Appendix 2 describes further features of these archetypes and Appendix 1 provides some illustrative examples. The archetypes are not alternatives. It is possible to envision a company participating in innovations that draw on both strategies. The archetypes are distinguished more by reference to the extent of change, the scope of participation and the potential for innovation.

The expert group suggest that competitive and sustainable production ultimately requires a shift toward sufficiency in production and consumption systems, although, modernisation strategies based on efficiency are presently more common.

Shifting development paths towards sustainable development



Source: ECOTEC for DG ENVIRONMENT

Sufficiency is concerned with the search for, and implementation of, new ways to meet human needs. Sufficiency addresses the services required to meet needs and the performance in use of material products. This is seen as a proper focus of future EU RTD&I policies and actions that strive for competitiveness and within a framework of sustainability.

Generating sufficiency, and integrating new process technologies, products and socio-technical systems provokes the need for new indicators of performance. The group concluded that more work is needed to refine the range and type of indicators available even though a large amount of work that has been done to develop indicators of outputs and outcomes. In particular, indicators are needed that reflect the uncertainty of technologies and systems, which will have to be experimented with in the next fifteen to twenty years. A range of indicators will have to be developed, which monitor the quality and effectiveness of social processes and their integration with the technologies being tested, while recognising their effect on environmental change.

6. OVERALL POLICY CHALLENGE

The overall policy challenge is to establish a climate that fosters and supports sufficiency strategies. This will involve the design of:

- **production systems** that are competitive and sustainable in concert with networks and clusters of manufacturers and networks of other actors;
- **distribution systems** that are competitive and sustainable in concert with networks and clusters of producers and distributors;
- **consumption systems** with consumers and producers that are sustainable;
- **integrated production, distribution and consumption systems**.

This will involve new platforms for participation by actors to encourage the development of modern technology and the reorganisation of socio-technical systems and social structures. It requires drivers as powerful as the ones that created the unsustainable practices of the past and present. This will impact the mix of policies [for example taxes, incentives, capital write-offs and agreements for trade] that support change. It requires multi-disciplinary, multi-sectoral, technical and managerial capabilities. EU RTD&I should stimulate these platforms and encourage a better, and more widespread, understanding of the overall process described above and its introduction into education and practice. Present RTD&I policy, with its emphasis on collaborative projects, is not seen as providing a basis to foster and secure sufficiency strategies. RTD&I policies and actions therefore need to be redesigned. And the mix of existing policies that present obstacles to sufficiency need to be changed.

We highlight some of the implications of this overall challenge below:

6.1. The Challenge of Participation, Collaboration and Learning

Companies in a number of European countries are pioneers of the managerial capabilities that underpin sufficiency strategies. They have developed highly participative structures in business and experimented with new forms of work organisation. There are examples of companies seeking to implement strategic change to bring about sufficiency. Examples are found in manufacturing based on natural resources such as forestry or foods. For example, Unilever is engaged in collaborations with the fishing industry on sustainable fisheries, and is working on ideas for sustainable agriculture with farmers groups. Unilever recognises the extensive changes

in business strategy, business models, management practices and attitudes and the collaborations required to contribute to sustainable production. Yet these efforts have not been widely adopted in manufacturing, with the result that Europe is presently not well equipped to respond to the radical changes envisioned in a future competitive and sustainable production sector.

Future manufacturing will involve more intense networking of organisations and new collaborations between unlikely partners. Communications technologies will facilitate extensive co-operation between partner organisations but this will need to be supported by managerial skills and institutional mechanisms that encourage and reward collaboration.

Co-operation and collaboration link strategic, operational and R&D activities as there are many types of actors involved in innovation within companies. Actors contribute different roles in supporting and encouraging innovation: strategists, R&D managers, financiers, collaborative partners, suppliers and consumers. Some of these are important in defining the boundary of the socio-technical system; others support the process of innovation or provide the resources that enable change. Establishing the location of competition and collaboration among the different actors in the system is particularly demanding.

The expert group identified institutional, organisational obstacles to these processes. These need to be overcome. They include:

- Different management styles and cultures in Europe [this obstacle should not be overcome by reducing the diversity of the European system, as diversity is a potential source of innovation].
- Different cultural and linguistic approaches to collaborative processes.
- Lack of coherence and perverse incentives in the overall mix of policies [for example taxes, subsidies, capital write-offs, and trade agreements are often contradictory and do not support sufficiency and sometimes not even economic and environmental efficiency].
- Weak participation by the private sector in public policy making and weak collaboration between private and non-governmental interests.
- Relatively low levels of co-operation and collaboration in research and innovation.
- Absence of initiatives that bring together potential partners across sectors and interests.
- Inability of consumer groups and other actors to engage effectively in learning and innovation programs.
- Poor mechanisms to diffuse good practice in learning and knowledge development.
- Continuing confusion between environmental management and sustainable development.

Organisational learning, the development of future scenarios and identification of visions, are important so that innovation can then take place through the informal and de-centralised exchanges in highly networked organisations. The transformations required by sustainable development will also involve the translation of what is learnt into new systems, structures, processes and products through new collaborations between organisations. Managerial capabilities that enable this process include the ability to facilitate visioning, learning processes and networks, systems integration and systems thinking, the integration of multi-actor, multi-disciplinary, multi-functional, multi-sectoral groups and the capacity to link competitiveness and sustainability. These are rare and difficult to reproduce skills. Moreover, sufficiency strategies oblige actors to learn new ways to learn.

While the principles of organisational learning and knowledge development are known, they are not widely diffused and practised in European companies involved in production systems. Neither is there wide experience of collaborative platforms of societal actors using these approaches.

European industry is particularly hampered by the following organisational and managerial deficiencies:

- Risk aversion in committing resources and forging new organisational collaborations around innovations.
- The low disposition of organisations to support life-long learning at all levels of enterprises.
- Shortages of capabilities in systemic thinking and systems integration.
- Scarcity of facilitation skills and the skills to support multi-actor, multi-disciplinary, multi-functional, multi-sectoral processes and platforms.

The new institutional and organisational settings that support learning have to be shaped through the active participation of learners through a process of social dialogue.

6.2. Education and Life-Long Learning for Change

The education system can foster the capabilities that support designs for sufficiency. As the character of sustainability and the conditions for competition are constantly changing there is a

need to support life-long learning for change. The types of changes required in the education system are shown in Box 6.1.

Box 6.1 - Revision of Educational Programmes

Education in engineering, management and science must undergo change in order to prepare graduates to work and lead in the new industrial world. Educational programs, particularly [but not exclusively] in engineering need to undertake change.

- Engineering and science education and practice should be anchored more firmly with industry as it modernises while retaining its scientific rigour.
- It is necessary to define a curriculum for engineers, scientists and managers who form a new cadre of systems integrators, capable of linking technical and managerial specialists and lay people in the process of sustainability.
- Systems integrators will need to work with specialist engineers and managers who can accept more multi-disciplinary approaches and multi-actor processes.
- Engineers require experience of 'design-build-operate-maintain' and preventive engineering and operation and maintenance skills.
- Students should be educated to work better in teams, as multi-disciplinary teams are necessary to deal with the complexity of today's tasks.
- Preparing students for living and working in an international environment requires universities to co-operate with organisations, governments, and industries in many other countries.
- Continuous development and utilisation of information technologies in education, is essential no matter how rapid the pace of technological change.

Formal education can raise awareness of the links between environmental, social and economic issues at all levels. However, evidence suggests that experiential learning is more valuable than formal classroom teaching in the development of the capabilities set out above. Schools and universities therefore need to engage with partners in a variety of sectors to provide learning experiences for students, enabling them to develop and perpetuate these skills. Business has a role to play as partner, educator and learner.

7. CONCLUSIONS

In the preceding sections we argue that competitive and sustainable production systems in Europe will involve a more integrated arena for innovation than has hitherto been envisioned. Integration has many dimensions. It requires the redesign of technologies and socio-technical systems. Moreover, as social-technical systems span both production and consumption, integration involves many actors in identifying and working towards purposeful change. It involves assessment of the economic, environmental and social performance of designs as well as the

connection of global pressures and local conditions. Realising these designs has implications for direction of RTD&I policies and actions in Europe. We advocate that the current approach to RTD&I at the EU level, with its emphasis on collaborative research projects, will not realise the integration and real gains that are necessary. We suggest a new focus for EU RTD&I policies and actions to foster transformation of socio-technical systems through sufficiency strategies. This will involve systems organisation and integration and the resolution of a range of obstacles in present innovation systems and rigidities in existing socio-technical systems.

In our conclusions we set out the rationale for public support for this approach; the role and contribution of science and research; the requirements that support and foster the more integrated approach we advocate; and a set of recommendations for RTD&I policies and actions consistent with this orientation.

7.1. The Rationale for Public Policy Support for Technological Innovation for Competitive and Sustainable Production

The rationale for public policy support of RTD&I for a competitive and sustainable production system is:

- The need for skills to integrate social, environmental and economic issues.
- The need to hasten the generation of technologies, knowledge and capabilities required for European-wide adjustments and transformations in industry based on sufficiency.
- Support for the managerial and institutional capabilities that underscore innovation for modernisation and sufficiency.
- Securing production that leads to a greater portion of industrial added value from the service value embodied in products.
- Promoting organisational clusters and networks with distinctive manufacturing competencies as a source for national and EU competitiveness and a basis for innovation.
- Integration of production - from design through to distribution - to facilitate enhanced flexibility, resilience, specialisation and differentiation in support of agile and customised manufacturing.
- Integration of production and consumption to facilitate more rapid modernisation in the direction of sufficiency.
- Generating and demonstrating new ideas and new designs as a foundation for European modernisation.
- Supporting the overarching objective to maintain the political, economic, social and environmental security and integrity of the EU zone, its Member States and its neighbours.

7.2. Supporting Research

Research has a central place in more competitive and sustainable production systems.

7.2.1. Natural and Physical Sciences and Research

Natural and physical sciences and research have an important role in the transformation of European production systems.

- Base-line studies are required of the cause/effect relationships between the physical aspects of environmental problems, such as climate change.
- Science and research contribute to our understanding of the effects of current activities on fundamental natural and physical processes and the search for damage limiting remedies. These studies are based on the notion of state, pressure, response models.

Developments in sustainable chemistry and new materials contribute to pollution- and waste-free materials, as well as materials and compounds with properties of durability, reusability or low-energy manufacture. Research supports miniaturisation and the development of molecular construction of materials as well as improved characteristics for recycling and re-manufacture. It contributes to the development of new energy sources and distribution formats.

- Emerging areas of research are biotechnology and materials in relation to nano-technology.
- Energy research is needed on fuel cells and renewables and micro-power systems.

There have been gains in our ability to model production systems around the design properties of natural systems with their more efficient use of energy and material flows.

- The combination of physical and natural sciences support the application of principles for pollution prevention, cleaner production and industrial ecology.

7.2.2. Multi-disciplinary Science and Research

Strategies for sufficiency require scenarios and foresight methodologies. These multi-disciplinary procedures:

- Examine alternative futures, and use back-casting techniques to identify stepping stones and pathways to desired futures. Foresight calls for structured methodologies. These include procedures for developing and extracting expert and non-expert opinion, techniques for exploring human needs and expectations, as well as morphological approaches to technological change. They include assessments of alternate pathways using life-cycle analytic approaches to identify environmental, economic and social aspects of alternate pathways and overall systems change; and technology gap assessments.

Many of the consequences for the environment and humans arising from the exploitation of research and development need to be subject to cautious scrutiny so that their potential is not realised at further cost to environmental limits or social coherence. There is a need to develop the means to scrutinise and better discuss the social and environmental consequences of new technologies. This should happen at an early stage in their development.

- Physical and social science need to collaborate to develop better multi-disciplinary systems to govern the scientific and social uncertainties and ethical concerns arising from new technologies, particularly those that exploit genetic manipulation.

Business and public policy have failed to anticipate and mediate the undesired consequences of change. There has been a general inability to promote more sustainable products and services requiring changes in behaviour or routines. What is missing is an understanding of risk, precaution and its relationship to change.

- Multi-disciplinary research is required into more precautionary approaches to science, research and development and technology.
- Social and physical sciences have a role to support the development of the visions that lead these experiments and tracking, facilitating and understanding processes that lead to desired change.
- New indicators are required of progress and transformation processes, which break with existing contexts and established criteria of performance.

7.2.3. Social Science Research

Conventionally, RTD&I programmes encourage competition among firms, research institutes and other parts of the innovation system. What is needed, however, is research that aims to support the sharing of new knowledge.

- There is a need for research that identifies modes of co-operation, collaboration and participation by actors in innovation systems. For example, this might focus on failures and successes in the adoption and diffusion of advances in physical science based technology; the effectiveness of multi-actor, multi-disciplinary, multi-functional, multi-sectoral processes; as well as examples of good practice, levers and processes that support change toward competitive and sustainable practices in production systems.

Social science contributes to capacity building and an understanding of the barriers to innovation and change. Through:

- Development of techniques, processes and strategies for the educational development and training of systems integrators and the advancement of process skills.

- Action research on the development of different models of public [political] and private [firm] decision-making; and the monitoring and evaluation of new concepts of 'progress' and 'development'.

- The contribution of demonstration projects and illustrations of good practice as a basis for behaviour change. In particular, the need to focus on the contribution of information, communication and computer technologies in supporting access to knowledge and knowledge distribution.

- Research contributes to our understanding of public scepticism about business and government and the extent to which new governance mechanisms command public support and endorsement and are viewed as transparent and trustworthy. Particularly, the role Non-Government Organisations [NGOs] as sources of information or partners in governance.

The social sciences, and especially economics, have concentrated their research on short-term issues. Social sciences are expected to contribute to our understanding of decision-making as society takes a stronger lead in driving towards socio-technical systems that are competitive and sustainable.

7.3. Developing Better Integrated Approaches

Better-integrated approaches are needed to combine results from a number of policy fields.

7.3.1. Problem-Finding and Problem-Solving Approach

The problem-solving approach is important in focusing RTD&I actions. Yet problem-solving in present policy is based on problems defined more as technological bottlenecks – for example the need for new catalytic converters – rather than in terms of unmet societal/human needs – such as clear air. It is necessary to develop more open, problem-finding approaches, with problem-solving a secondary feature of the same type of multi-actor process. Problem-finding and problem-solving should be conducted at the level of the socio-technical systems rather than focus on individual technologies.

7.3.2. Creating Appropriate Drivers and Policy-Mix

Companies respond to market drivers and innovation opportunities. Policy should be co-ordinated to open up new possibilities for companies to pursue sufficiency strategies with other societal actors. While there are strong market based drivers and a mix of public policies [incentives, taxes, trade policies, environmental standards] that support competitiveness these are often contradictory, even within the efficiency archetype. Similar drivers and policies to support sufficiency solutions are weak. They need development. A critical challenge is creating markets,

or more precisely, creating demanding consumers for solutions that are competitive within a framework of sustainability. The lead market concept provides examples of the conditions under which certain sectors of industry can develop successfully in those markets.

The report's focus on production and consumption, bridged by the concept of the socio-technical systems and the network of actors in those systems, means that the unit of analysis, and the focus of future RTD&I policy as we see it, is technology in use. Market drivers and the mix of policies have specific impacts on individual socio-technical systems. This means that the members of the group did not feel able to advocate the specific changes to resolve the market and policy barriers to the design of more competitive and sustainable systems without detailed analysis of individual socio-technical systems. This analysis is seen as one of the tasks of platforms charged with redesigning socio-technical systems. These policy issues need to be addressed and resolved in concert with a coherent set of measures designed for each socio-technical system.

Moreover, competitive and sustainable production is a subset of a broader mix of activities that contribute to sustainable development. The arena for competitiveness and sustainability is therefore not only the specific to a socio-technical system. It is European and global. The policy framework with its social, economic and environmental dimensions is equally wide. Policies and actions for sufficiency must form part of an umbrella of policies that drive toward sustainable development as the goal of EU development. At the same time policies and action must enable solutions that are relevant to local conditions, and fit needs at other levels – national, regional, global. This requires pooling of knowledge and resources and co-ordination of activities to ensure effective responses. This is not a trivial task.

Alignment of these objectives with general environmental policies and industrial policies at both national and EU level is an important dimension of the policy mix. Yet industrial and business development policy will have to be tailored for individual sectors depending on their specific impacts on sustainable development. RTD&I policies for these sectors must also have a multi-sectoral dimension within an overall framework, which is co-ordinated with other policy fields. The approach to tailoring of sector specific policies should extend the problem solving approach that was adopted by the EU in the 5th Framework programme.

7.3.3. Communication

Communicating the changes that support competitive and sustainable production and sufficiency strategies presents many problems to business and public policy. For example, the social acceptability of economic instruments to change behaviour – such as water metering and fuel tax – depend on public confidence. One way to bring this about is by addressing the perverse incentives that support unsustainable uses of resources, energy and materials.

Economic instruments have the potential to stimulate the market. However, to be successful in delivering behavioural change, consumers need to have clearly communicated alternatives. Consumers are not persuaded by price alone. This will be supported if Governments have a clear and consistent direction for policy that encourages companies and individuals to invest in alternative solutions.

7.3.4. Capacity Building

An overall issue for public policy is building capacity to bring about the vision stated earlier in this report. This will not be achieved through any one of the approaches but by combining these changes in new innovation systems with wider research and scope. Maintaining intensive communication between actors is critical to capacity building and in the design and implementation of solutions.

ICT and other enabling technologies play a role, as do new horizontal and vertical lines of communication between organisations and individual actors. Capacity building should be focused on technologies and their application in social systems.

The decline in interest in physical sciences in schools in Europe needs to be arrested and positive steps taken to create a cadre of high quality young multi-disciplinary and transdisciplinary scientists and researchers. Programme rules in EU research programmes should be reviewed to ensure obstacles inhibiting participation of unconventional researchers and thinkers are removed.

7.3.5. International RTD&I Objectives for Competitive and Sustainable Production

The group saw RTD&I for competitive and sustainable production as an important element of the EU's international policy given the global dimension of many problems addressed by sustainable

development. International co-operation and collaboration is a clear imperative. Examples of some of the areas that need to be addressed are:

- Co-operation with other developed, industrial economies on key global challenges of industrial development based on sufficiency.
- Concerted unilateral or multilateral support to developing countries to promote pathways to development based on sufficiency.
- Co-operation with developing economies and economies in transition to tailor solutions to their unique circumstances and needs.
- Commitment to capacity building in developing countries through the transfer of capabilities and skills especially those related to systems integration and the development of improved processes of participative technology assessment and development.

The first two categories potentially involve multilateral policies of co-operation with developed economies. The other two categories would be suitable for bilateral co-operation between the EU and developing countries.

7.4. RTD&I Policy Recommendations

Realisation of the vision of the Group [section 3.2.] will enable a wide range of human needs to be met into the longer-term future. However, the transition envisioned in this report will not be easy. It will require migration from a culture of material throughput to sufficiency as the basis for growth through value added.

The expert group identified the need for a broader and more flexible set of policy instruments in support of the shift to sufficiency as a basis for competitiveness within the framework of sustainable production systems. Stimulating and accelerating the shift to sufficiency in socio-technical systems requires:

- 100% funding of search exercises for key socio-technical systems to generate ideas and commitment to examine sufficiency solutions that moderate material consumption and sustainable product service offerings.
- Funding support for a remodelled R&D infrastructure and the innovation system that reflects the demands for new knowledge, the new context for interaction with industry and the requirement for new skills and capabilities.
- An important new element of innovation infrastructure is establishing international competence networks as a basis for research and the dissemination of research results. These networks should be set up for a period of 5-10 years [maximum], equipped with a [relatively] stable budget and a strong communications remit. These competence networks should form nodes in a broad Europe-wide communications and co-operation network

- Restructured RTD&I policy administration to reflect the participative approach and process that is being encouraged for RTD&I – i.e. policy administration should be multi-disciplinary and participative, experimental and possibly open to continuous interaction with EU experts and supported RTD&I partnerships. This might involve experimentation with continuous process evaluation and mid term corrections in projects.

This will affect public policy, business management and public attitudes. It will require a suite of policy instruments that create a climate in which processes for learning and collaboration, good practice and goals are cultivated for individual socio-technical systems, rather, than applying standards, conformance and outcomes. Encouragement of appropriate financing mechanisms to support the innovation effort will also be an important instrument of public policy. These will have to be more socio-technical system and area specific.

7.4.1. RTD&I Policy Instruments

RTD&I policy instruments can be structured in the design framework presented at the beginning of these conclusions.

The generation of ideas for innovative approaches to sufficiency strategies for selected socio-technical systems.

- Foresight forums through which societal groups, at the European level, can generate new ideas and learn about the expectation of relevant actors for competitiveness within the framework of sustainability in relation to specific socio-technical systems.
- Maximum encouragement for maverick, or wild card, approaches to RTD&I based on a continuously open call within the theme area of Competitive and Sustainable Development. Proposals should be subject to multi-disciplinary evaluation to ensure the widest possible relevance of research proposals.
- Specific funds designated for competitive and sustainable innovations, which have merit but do not meet traditional criteria.

Understanding Socio-Technical Systems.

- Participative forums to establish the key actors involved in specific socio-technical systems, and, to identify and map the specific characteristics of those systems and actors needs and interests.
- Establishing the basis for inputs and contributions by actors to collaborative action.

Resolving the barriers to change and establishing the feasibility of solutions.

- Addressing knowledge transfer and knowledge access problems and organisational barriers for companies, which want to adopt sufficiency strategies.
- Establishing appropriate cost accounting and financial control mechanisms that reflect the true economics of material recovery and material assets held in product-related service systems.

- Schemes to develop capabilities for performance rather than products that support workers to become service providers.
- Supporting inter-firm co-operation mechanisms using information technology & knowledge management and logistics, especially on reverse supply chains and take-back schemes.
- Establishing and resolving barriers arising from the demand for venture capital oriented toward sustainable development projects.
- Identifying and pressing for a mix of policies that is more supportive of sufficiency solutions in specific socio-technical systems.

Supporting the development and adoption of enabling technologies.

- Emphasising basic science and research in technologies, which allow decentralisation of systems. Highlighted areas are the information and communication technologies, biotechnology and micro and nano-technologies as they appear to represent enabling technologies for sustainable development particularly in the areas of dematerialisation and resource productivity.

Engaging a variety of relevant actors to participate in the process of learning and change.

- Incorporating societal and environmental actors in programme committees of the Framework Programme.
- Broaden the knowledge base on sustainability innovation mechanisms: establishing an expansion of surveys on sustainability in manufacturing practice [cf. ISI-data]. Carry out socio-economic research on sustainability management and innovation management as well as introduce a voucher system for societal groups, which allows them – if collaborating – to give research grants.
- Develop the contribution of socio-economic experts, as a support input/vision to RTD&I in relation to social needs, as in the example of the Vision Zero Strategy in Sweden on reducing road deaths.
- Training participants in effective procedures and facilitation: managers must learn to have an interactive approach to innovation management, with internal and external partners. The training of societal groups on corporate innovation management allows them to have most impact as well as the training of moderators.

Demonstrating and disseminating these processes and their outcomes to others.

- Assessing and developing a policy-mix that encompasses legislation and taxation that allows technical alternatives [through R&D for technology] to be examined in advance of drafting directives etc.
- R&D in hard sciences in support of areas of public sector spending where the objective is the promotion of competitive and sustainable solutions.
- Action research on the demonstration of the principles for future production systems in action, and demonstration of participation in action.
- Multi-actor Implementation Forums for RTD&I and sustainability at levels appropriate to specific socio-technical systems.
- Database and resource guides on good practices of SMEs and other actors involved in sufficiency approaches [particularly for companies not in existing networks].

- Socio-economic shadowing of the process of mainstream RTD&I research with monitoring in real time, with the objective of presenting challenges, learning and disseminating rather than evaluation policy implementation.
- Development of guidelines for sustainable production systems such as those outlined in section 5.1 of this report.

This design framework should be guided principles spelt out in the report [lightness, flexibility, durability, adaptability, and closed material loops] that affect the character of the systems that emerge from the design process. The processes that are used to envision, assess and promote those systems should be based on mutual learning and joint action.

Appendix 1 - Examples of Sufficiency through Product Extension

Selling the performance of durable products through systems such as operational leasing, rental, and BO [build and operate]

'Rental systems' sell performance rather than material products. Ownership and product responsibility remain with the manufacturer or fleet manager. Examples include Xerox and Océ Data's photocopiers. Other areas are industrial markets for aircraft, cranes, clothing, sports equipment, and artificial hearts, but also engineering works such as toll bridges, motorways and the 'Chunnel'.

The production system in the EU lags the industrial world in this field. It has a negative trade balance in operational leasing with the USA, Japan, and the World.

For example, Xerox's strategy of operational leasing sells 'customer satisfaction', the only payment is a fee per copy made. No distinction is drawn between new and remanufactured equipment and parts; preventive engineering is the key to profit for companies operating in this way.

Selling durable products with profitable take-back after utilisation

Examples of product take-back after utilisation by manufacturers include single use cameras [SUC], car tyres for retreading, furniture, GE medical systems, combustion engines [GM, Caterpillar and Volkswagen] and computers [IBM].

The EU lags behind the USA in this domain but many US companies are quietly active in Europe.

GE medical systems started a take-back programme in 1991 with a pilot scheme in the US. Once profitability had been demonstrated, a proper plant was built. Today, GE takes back the medical equipment of any manufacturer and turns them into new products and profit.

IBM began its Global Asset Recovery Programme for computers in 1999, after it was convinced through a pilot programme that it was possible it was profitable to prevent 93% of waste through product-life extension of components.

Catalytic products, such as dry cleaning fluids and engine oil, also fall under this category.

Selling 'chewing gum goods' for re-use [hidden rental strategies]

'Chewing-gum goods' are short-use products that are discarded when the fun [of use] is over. However, even 'chewing-gum' can be 'waste-free' if accompanied by bring-back incentives, as illustrated by Kodak's single use cameras [SUCs]. To receive pictures, the customer takes the SUC to a photo lab, which returns it to the manufacturer for a token fee. SUCs are therefore rental cameras that are intensively reused in loops controlled by the manufacturer. Kodak, for instance, has take-back programmes in 20 countries and manufacturing sites in Europe and the Americas.

Since 1990, Kodak has collected and profitably put back into use ['recycled'] almost 300 million cameras worldwide. The cameras are sorted by centres which employ people with disabilities, cleaned and fed to an assembly line, where sensitive parts are manually replaced with new ones,

and other parts undergo rigorous quality testing. The sub-assemblies are then shipped to Kodak for re-fill and re-sale.

Waste is prevented through design for durability and dismantling. Cameras are designed to be used at least ten times. Parts that cannot be reused are ground into pellets and remoulded into new camera parts. Compared to standard cameras, SUCs create only a fraction of the waste [Eastman Kodak, 1999].

Manufacturing v. Re-manufacturing

Higher resource productivity [dematerialisation] makes economic sense in a loop economy. This opens new areas for innovation and technology through:

- longer utilisation of products through dematerialised components and products that can be adapted to changes in fashion and technology. Their maintenance, re-manufacture and re-used increases the competitiveness of an economy and the company [Philips is working on the concept of modularised domestic electrical equipment such as televisions].
- more intense utilisation of products. Dematerialisation, sufficiency, multi-functional goods and shared utilisation, the sale of results instead of products, and system solutions instead of products, are strategies for economic success in a service economy.

The re-use, repair and upgrading of products are local activities, whereas the re-manufacturing of products and the recycling of materials are regional strategies that close material loops. Re-manufacturing provides a competitive and sustainable way to replace global factories by regional workshops and retain value at the local level.

System solutions, such as the voluntary take-back of products, and rentals instead of sales, are strategies that close product and material responsibility loops. This replaces ‘cradle to grave’ responsibility with 'cradle back to cradle' responsibility. The cradle back to cradle approach internalises the costs normally be associated with disposal and thus lead to changes in business strategies.

The question remains whether re-manufacturing should be regarded as an efficiency or sufficiency strategy. Re-manufacture uses many processes that stem from production [efficiency], but with economic incentives similar to sufficiency. In particular sufficiency becomes an economic incentive; skilled labour is the main resource employed and a low importance is attributed to economies of scale in economic optimisation.

Europe has world leadership in the remanufacture and maintenance of aircraft. Lufthansa Technic has 11% of world market share and Swissair’s SR Technics has around 5%. In the past aircraft fleet operators remanufactured in-house. Fleet managers then outsourced remanufacturing to specialist remanufacturers. The trend now, in the case of jet engines, is moving from remanufacturing services to operational leasing of jet engine services.

Appendix 2 - Selling Performance versus Selling Products

Efficiency Strategy **Sale of a product** [industrial economy]	**Sufficiency Strategy** **Sale of a performance** [service economy]
The object of the sale is a product	The object of the sale is performance, customer satisfaction is the result
Liability of the seller for the manufacturing quality [defects]	Liability of the seller for the quality of the performance [usefulness]
Payment is due for and at the transfer of the property rights ['as is where is'-principle]	Payment is due pro rata if and when the performance is delivered ['no fun no money'-principle]
Work can be produced centrally/globally [production], products can be stored, re-sold, exchanged	Work has to be produced in situ [service], around the clock, no storage or exchange possible
Property rights and liability are transferred to the buyer	Property rights and liability remain with the fleet manager
Advantages for buyer: - right to a possible increase in value - status value as when buying performance	Advantages for the user: - high flexibility in utilisation - little own knowledge necessary - cost guarantee per unit of performance - zero risk - status symbol as when buying product
Disadvantages for buyer: - zero flexibility in utilisation – own knowledge necessary [driver licence] – no cost guarantee - full risk for operation and disposal	Disadvantages for user: - no right to a possible increase in value
Marketing strategy = publicity, sponsoring	Marketing strategy = customer service
Central notion of value: high short-term exchange value at the point of sale.	Central notion of value: constant utilisation value over long-term utilisation period.

Source: The Product-Life Institute, Geneva