

The challenge of sustainable manufacturing – four scenarios 2015-2020^{1, 2}

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Abstract

This paper explores the prospects for sustainable manufacturing. How will manufacturers respond to the future challenges in the socio-economic business environment and technological change? What is the scope for sustainable manufacturing assuming different socio-economic development paths? How will manufacturers adapt their Corporate Sustainability strategies to these developments? The paper throws light on these questions. We present four socio-economic scenarios which were developed in the framework of the FP5 Accompanying Measure “The Future of Manufacturing in Europe 2015-2020 – The Challenge of Sustainability”. The scenarios serve as a tool to discuss the possible scope and likely approaches to sustainable manufacturing. The scenarios indicate that sustainability is only one among a set of critical issues manufacturers will have to address to maintain their competitiveness in the future: improving supply chain efficiency, acquiring and managing knowledge, anticipating new market needs, and adopting new technology are other challenges that will shape manufacturing. The balance industry will seek to tackle these competing (and partly conflicting) issues will result in trade-offs with

regard to the pace and direction towards sustainability in manufacturing. We argue that corporate sustainability portfolios will vary depending on the broader socio-economic and policy environment. In relation to policy making in support of pro-active corporate sustainability strategies we propose to concentrate on options that help to avoid less desirable future states to emerge and – at the same time – prove to be effective in many different scenarios. The paper suggests as such promising policy approaches the introduction of fiscal instruments, the exploitation of Europe’s strengths with regard to sustainable technology, stakeholder involvement, paying attention to second-order effects of socio-technical change, and incentives for the development of more sustainable consumption patterns.

Introduction

In May 2001 the European Council in Gothenburg endorsed the European Commission’s proposal for a European Union Strategy for Sustainable Development (CEC 2001a). In this document, the Commission sets out a strategic long-term vision of Sustainable Development, aiming at a society that is more prosperous and just and that reconciles economic growth, social cohesion, and environmental protection. Among the strategic objectives and targets set in the EU Sustainable Development Strategy are:

- breaking the links between economic growth, the use of resources and the generation of waste,
- decoupling transport growth significantly from growth in GDP,
- reducing greenhouse gas emissions by an average of 1% per year up to 2020,
- phasing out subsidies to fossil fuel production and consumption by 2010,
- raising the share of alternative automotive fuels to 20% by 2020,
- ensuring that by 2020 chemicals are produced and used in ways that do not pose significant threats to human health and the environment;

- the promotion of more balanced regional development by reducing disparities in economic activity; and
- raising the employment rate in Europe to 70% and increase the average EU employment rate among the 55-64 years olds to 50% by 2010 (CEC 2001a).

The task ahead to attain the ambitious objectives and targets of the EU Strategy is substantial and making Sustainable Development a reality will require broad policy commitment. Sustainable Development will require major changes with respect to production and consumption patterns in our societies, including materials, energy sources and production processes used in industry, the products and services offered, as well as the organisation and management of supply chains and the governance of firms. Industry, and the manufacturing sector in particular, is therefore one of the key addressees of the Sustainable Development strategy since a more sustainable manufacturing sector can make significant contributions to attain the European objectives.

In this paper, Sustainable Manufacturing refers to the vision of a production systems, in which “production and consumption support the quality of individual and social life, in ways that are economically successful while respecting environmental limits ... [K]nowledge and technology, capital, resources and needs are harnessed and governed so people can live better lives while consuming less material resources and energy” (CEC 2001b). With Corporate Sustainability we refer to company’s strategies to implement sustainable manufacturing. It comprises all corporate activities that contribute to the above mentioned vision of Sustainable Manufacturing and to the achievement of the strategic goals and objectives set in the EU Sustainable Development Strategy.

Even though much depends on changing manufacturers practices to achieve sustainability, it is

not entirely in the hands of industry to bring about this change. Sustainability will not be shaped exclusively within the boundaries of the firm. The scope for industry’s action to introduce more sustainable products, services, and business practices will depend on a wide range of external factors outside the control of individual companies. Among these are technological change, geo-political developments, socio-economic and demographic trends and trend-breaks, the regulatory environment and systems of governance, changing values and future demand patterns.

Most of the shaping factors cannot be assessed or forecasted with accuracy on a fifteen to twenty year time horizon, the timeframe on which the strategic objectives and targets of the European strategy for Sustainable Development are set. What is certain, however, is external factors will impact on manufacturing and on the decisions companies will take in the future. Furthermore future socioeconomic states will determine the available policy portfolio and the effectiveness of instrument in support of sustainable manufacturing.

How can we cope with the problem of assessing the prospects for sustainable manufacturing in the face of uncertainties about future developments? How is it possible to make assumptions about company approaches, policy options and their impacts on sustainability in the European Union by 2015-2020? The approach taken to tackle these issues in this paper is based on four explorative scenarios that aim to span the European futures. The scenarios describe in general terms possible socio-economic futures in Europe. Although they were not developed to specifically address the issue of corporate sustainability, they paper shows how they can be used as a conceptual tool to frame the interactions between socio-economic factors, technological developments, and company priorities with regard to sustainability. The scenarios are a

means to reason about companies' scope for action and strategies assuming they are confronted with different futures. From this analysis indication for policy options to facilitate proactive corporate sustainability behaviour can be derived.

The paper is structured in four sections. In Section 2 we describe the scenario approach of the FutMan project and illustrate the four scenarios that aim to span the range of possible developments on a fifteen to twenty year time horizon. In Section 3 we aim to examine the likely industry priorities to cope with challenges the scenarios represent. In this section we also take a closer look at the specific corporate sustainability strategies and approaches. In the conclusions (section 4) we provide some indication about expected trade-offs for sustainable development and discuss briefly possible policy options to facilitate pro-active company behaviour that seem to be effective in a broad range of potential futures and/or that might help avoid the materialisation of undesirable developments.

The FutMan scenarios

Conceptual framework of the FutMan scenarios

Scenario building about the future is a method for strategy development. Broadly speaking one can discern two different types of scenarios. *Normative* scenarios usually portray a vision or desirable futures. The strategising actor (or actors) then asks "What steps are necessary to take to make this vision become reality?" Normative scenarios can be useful tools for strategy development if the cause-effect relationships between the factors that impact on the scope of the scenario are well known and the scenario drivers can be sufficiently shaped by the planning actor(s). Normative scenarios can also be used to support visioning between different stakeholders in order to develop strategic options for influ-

encing and stimulating innovations towards certain goals, such as sustainable development (Partidario and Vergragt 2002). The second approach to scenario building develops *explorative scenarios*, based on a broad set of key factors that highlight important trends, possible trend-breaks, critical challenges and opportunities in order to map the space for future developments. The explorative approach to scenario building assumes that the future will be shaped by the complex interplay between a wide range of environmental factors, of which only *some* can be *partially* influenced by the planning decisions taken. Furthermore, explorative scenarios often acknowledge that cause-and-effect relationships between factors and the future dynamics of the interplay between factors are unknown or accompanied with high uncertainty. The strategising actor asks: "What is the best we can do to pursue our goals if we are confronted by a certain environment?" The latter was the scenario approach adopted in the scenario exercise described in this paper.

For the development of the FutMan scenarios we called *drivers* all factors identified in the scenario exercise that will impact on manufacturing in Europe. The most important factors are called *key drivers*. Some of the drivers can be considered to be almost contextual, which means their development in the future will not be influenced (or only little) by developments and industrial approaches in European manufacturing. Such *contextual drivers* are for example geo-political developments and socio-demographic trends. Other drivers interact with developments in manufacturing and the strategies of industry, such as environmental regulation, technological change and developments in the labour market. These factors form the *transactional environment*. Besides the contextual and transactional environments which are *external* to manufacturing, there are also *internal drivers* of change. With *internal drivers* we refer to developments in manufac-

turing that can be understood as the responses to external pressures created by the environment (e.g. new regulation, changes in demand patterns) and/or the result of innovative industrial dynamics (e.g. increase supply chain efficiency, adopt new technology). Since all manufacturers develop strategies to address the internal drivers in order to keep/ gain a competitive advantage or to influence and shape the transactional environment, the internal key drivers were also labelled *key manufacturing challenges* in the FutMan scenario exercise.

With the scenarios on the Future of Manufacturing in Europe 2015-2020 (FutMan scenarios) we offer imaginative pictures about potential socio-economic and policy developments that shape the European manufacturing sector. The aim of the scenario exercise within the FutMan project was to develop a set off coherent long-term visions of 2015 to 2020 European manufacturing to inform EU policy makers in the area of industrial RTD and to provide them with a tool to stimulate strategic thinking.

In fact, the FutMan scenarios are meant to provide the context in which certain developments (i.e. both threats and opportunities) of European manufacturing and the robustness of European policy strategies can be discussed. In the scenario building process we paid particular attention to the goals and objectives of the sustainable development strategy of the European Union as a focussing device.

The FutMan scenarios were developed in a series of interactive workshops drawing on the subjective views and judgements of the more than fifty experts from industry, academia, and policy makers involved in the scenario building exercise.⁴

Key drivers and structuring dimensions of the FutMan scenarios

In the first stage of the scenario process the experts identified and discussed in a brainstorming session the key drivers, trends and break-points related to science & technology, economic and industrial change, environmental & sustainability issues, social factors, and the policy environment that will shape the future of manufacturing in Europe. Following an in-depth discussion of the links between factors and the ranking of their importance for manufacturing in the workshop, the issues were clustered into a set of external drivers and internal drivers of change in manufacturing (see Figure 1).

The main external drivers identified are customer demand patterns, governance and regulation, public values, environmental priorities, global developments, socio-demographic change, and progress in science & technology. The main internal drivers of change in manufacturing are related to the optimisation of the value & supply chain, improving sustainability of production, the acquisition and management of knowledge, the anticipation of new market needs, and the adoption of new technology.

As already mentioned above, the internal drivers were also labelled “key challenges” for manufacturing in the FutMan scenario exercise since they can be understood as responses to external pressures. The internal drivers can be mainly seen as responses to external pressures and change. Hence, in order to structure and describe the socio-economic scenario frameworks only the external drivers were retained. The scenario implications for manufacturing were then derived in a second step, taking the five endogenous drivers as focusing devise.

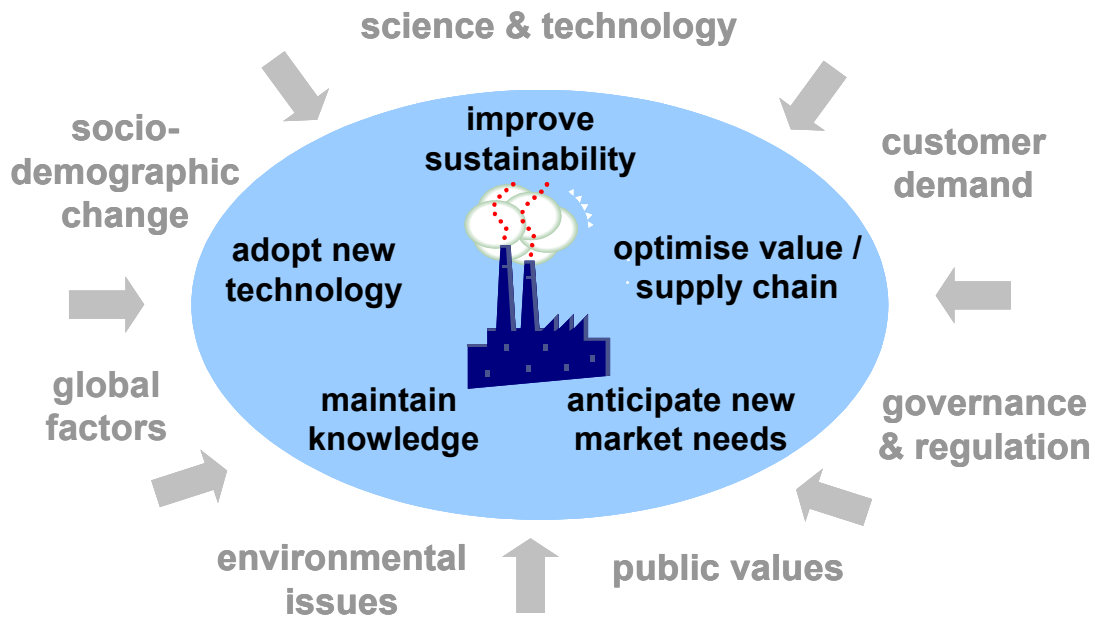


Figure 1: Internal and external drivers for European manufacturing

In order to structure the framework for the scenario building, the external drivers were further aggregated. There was wide agreement between the experts about the pace and direction of socio-demographic change in Europe within the next fifteen to twenty. Therefore this driver was considered a baseline in all scenarios. Likewise, the main environmental and sustainability policy priorities were assumed to be rather stable, largely reflecting the priorities and targets set out in the EU Strategy for Sustainable Development. More difficult was the handling of science and technology in the scenarios. Science and technology is both an external driver but has also internal characteristics: technological change shapes manufacturing, and at the same time, is shaped by the activities and priorities of industry. In line with prevailing evolutionary and constructivist approaches to innovation and technological change and to simplify the scenario building progress, science and technology was finally considered as internal factor, a manufacturing challenge. The experts adopted this approach since they agreed that industrial RTD priorities and the specific characteristics of technology adoption in products, services and industrial

processes will largely depend on the broader socio-economic, market, and policy environment.

The drivers related to policy making and demand factors were then used to structure the FutMan scenarios along two main qualitative dimensions of change (see Figure 2). The first structuring dimension refers to *modality of policy* which comprises developments related to governance and regulation in Europe and beyond. With *co-operation* mode of policy we refer to the deliberate co-ordination of policy between different levels of governments and policy fields with the aim to find consensus if possible, whereas in a *go-it-alone* world, policy actors will compete in pursuing their specific policy goals, without taking into account cross-governance or cross-policy impacts or aiming for multilaterally accepted decisions.

The second structuring dimension refers to the rationales that guide people's and companies behaviour and decisions. This dimension is closely related to public values and the prevailing perception of societal objectives, as well as the role of individuals and institutions to achieve

them. The experts argued that values and beliefs held by society will have significant impact on future customer preferences and demand patterns. In an *individualist* society, people will seek for unrestricted freedom to maximise their

individual utility. The notion of *citizenship*, in contrast, assumes that there are societal goals which cannot be achieved without taking into account broader stakeholder interests.⁵

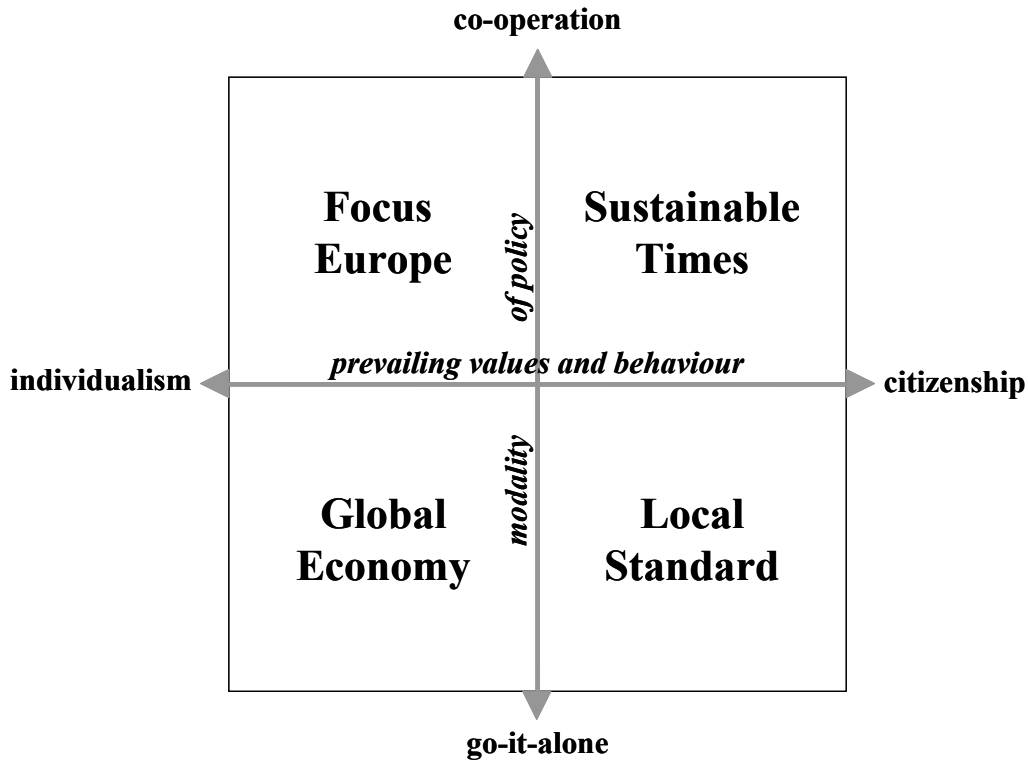


Figure 2: Structuring dimensions of the FutMan scenarios. The two structuring dimensions were combined to form a two-times-two grid. For each of the four quadrants that were created by combining the opposing characteristics of the dimensions used to structure the scenario space IPTS drafted preliminary scenario scripts. The socio-economic framework of each of the scenarios was then described by elaborating on the state of main socio-economic characteristics of the scenarios (Table 1).

Table 1: Main socio-economic characteristics of the FutMan scenarios

	Global Economy	Local Standard	Sustainable Times	Focus Europe
Global governance	WTO enforces free competition. Global social and environmental accords watered down.	Limits to globalisation due to lack of public acceptance. Emergence of new regional protectionism.	Emergence of global governance bodies to promote sustainable development.	WTO governs international trade. EU sets goals and pursues SD without international backing.
EU policy integration/ policy instruments	Low integration of SD policies. Reliance on market mechanisms and industry actions to achieve SD.	Low integration of SD policies. Regional interests set policy agendas and priorities.	Strong integration of SD policies between levels of governments. Regulation and market incentives.	Integration of SD policies with strong role of EU. Emphasis on cost-effectiveness of policies.
Consumer behaviour/ values/ demand patterns	Individualism and pursuit of personal utility. Highly individualised demand patterns.	Strong perception that community values and local dimension are crucial to achieve SD.	Community values and global dimension emphasised. Demand shifts from products to services.	Individualistic values dominate. Regulation corrects 'distorted preferences' of economic actors.
Innovation policy focus	Strengthen competitiveness and innovative capabilities of industry.	Create and strengthen regional and local innovation systems.	Tackle key societal challenges related to sustainable development.	Concentrate on strategically important research related to SD.
Transport / energy infrastructure	Liberalised, oligopolistic markets. Low energy prices. Little emphasis on renewable resource use.	Regional monopolies. High energy prices. Fragmented transport infrastructure and gridlocks.	Mixed public-private markets. High energy prices. Heavy investments in renewables.	Liberalised markets. Low energy costs. Little public investments in infrastructure for renewables.
Sustainable development	Strong emphasis on the economic pillar of SD. Growth seen as the prerequisite for SD improvements.	Policies mainly responses to local pressures by various interest groups. Regionally patchy picture.	Strong emphasis on the environmental and social pillars of SD guided by precautionary principle.	Aim to balance SD pillars through integrated policy assessment tools. Strong technology focus of SD.
Education system	Partial privatisation of the public education and training system. Multitude of private schemes.	Regional responsibility for education co-ordination. Industry involved in training schemes.	Governments retain lead role in education. Strong emphasis to strengthen EU knowledge base.	Co-ordination of public and private education schemes to improve the economy's knowledge base.
Priorities in higher education	Strong emphasis on scientific excellence along traditional disciplinary boundaries.	Diversity in education and training schemes, reflecting regional legacy and diversity.	Strong emphasis on interdisciplinary training, soft-skills, and problem solving capabilities.	Strong emphasis on scientific excellence, cross-cutting traditional boundaries of disciplines.
Labour market	Little co-ordination of labour market and migration policies. Widening spread of labour costs.	Regional initiatives to balance labour supply and demand. Large regional labour cost differences.	Co-ordination of labour market and migration policies. Emphasis on tackling labour market imbalances.	Labour market and migration policies co-ordinated by EU. Increase of overall labour mobility.
Social security	Social security is increasingly left to the individual's choice and responsibility.	Regional differences prevail. Social security becomes part of compensation schemes.	Harmonisation of social security system at EU level. Social security remains in the public sector.	Mixed public and privatised social security system within a compulsory framework.

In the FutMan scenario workshops the experts discussed, revised and validated these sets of basic descriptions of the scenario characteristics and used them as starting point for the development of the four FutMan scenario scripts presented below.

Scenario descriptions

Global Economy: "The market will get it right!"

In this scenario, consumers have pursued a narrowly defined notion of personal utility. Maximising immediate personal advantage without paying too much attention to environmental and social impacts of their actions is prevailing consumer practice. The free market has been considered the most effective way to allocate resources efficiently and to achieve sustainable development. Europe is under heavy economic and political pressure from other world regions to abandon its traditional economic policy and social welfare model. In this scenario, industry structure is highly specialised – but diverse – and tough competition exists between powerful,

globally acting producers. Other world regions, especially new entrants on the world market and powerful multinationals exert their economic and political interests with enormous vigour. Policy-making in Europe has been based on a 'small government' rationale. It principally has aimed to strengthen market mechanisms and competition. Policy makers in the fields of industry, trade, environment, competition, labour market and social policy have been competing with each other rather than aiming for policy integration across institutions or policy fields.

The scope for policy in support of sustainable development focuses on price incentives such as tax breaks, emission trading, and capital write-off schemes. Within the limits of competition rules, also the support of business RTD activities for more sustainability is pursued by the public sectors, in line with the actors' belief in the overall effectiveness of private entrepreneurship and market mechanisms. Voluntary agreements between industry and governments are an important policy tool in this scenario. Product liability laws compensate for missing safety and environmental standards. Court litigation has be-

come a source of product and process innovation – and a reason for the lack of it.

Local Standard: “We protect our communities!”

In this scenario, local authorities and regional governments have gained new powers. The European institutions are not strong enough to co-ordinate the interests of Member States and regions. As a consequence, at international level the European Union has not been able to establish itself as a powerful player. The civil society, represented by a wide range of NGOs, has become an important actor in local policy-making processes. Consumer association and citizen groups push their agendas on community issues. Whereas in some regions the citizens have shown a high level of awareness to environmental problems, in other regions economic and employment considerations have attained more attention. Trans-regional infrastructures have been suffering from bottlenecks due to shortfalls in investment and local opposition to new projects. Industry sectors which public opinion considers being risky, face heavy local opposition against new plants. The Local Standard scenario implies both the centralisation and the decentralisation of manufacturing operations depending on sectors and products considered. New regionally organised supply chain models and production systems emerge. The economic and social disparities between European regions and between Europe and its neighbours have remained substantial.

As far as policy making for Sustainable Development is concerned, a new regional protectionism has emerged in this scenario, with local and regional authorities imposing regulation in areas such as emission control, transport restrictions, spatial planning and permits for industrial activities. These are mainly the response to local bottom-up pressures. Besides protective measures the scenario also witnesses the use of public

procurement as a means to foster niche markets for innovative, sustainable products and services.

Sustainable Times: “Let’s all work together!”

In this scenario, European citizens have accepted and supported the government’s coordinating and regulating role to reconcile the economic, environmental, and social dimensions of sustainability. A global governance system has emerged. International accords safeguard Sustainable Development. Trade, economic development and environmental protection and social standards are dealt with within the same global institutional framework. European industry is a pro-active partner in sustainable development, closely collaborating with governments and the civil society. The energy system in Europe has been undergoing a transformation towards renewable energy sources. Socio-technical change has been occurring at fast pace, enabled by successfully linking technological opportunities with organisational and social innovation. Consumers take advantage of services rather than buying products. The patterns of working, living and producing have changed considerably as the notion of *quality of life* comprises more than increasing personal economic wealth.

Policy makers have aimed to find consensus between policy fields that impact on sustainable development. Policies to facilitate the adoption of new technology and organisational innovation take into account social responsibility issues proactively. Further, the public sector supports the transition towards renewable resources and re-directs its infrastructure investments accordingly.

Focus Europe: “Europe must use its muscles!”

In this scenario, European citizens take for granted that it is principally the government’s responsibility to deliver on sustainable develop-

ment. Individualist values prevail among EU citizens. However, they accept the regulating role of a strong central government. International trade has been facilitated through WTO. The scenario foresees oligopoly market structures. The Member States have increasingly devolved powers to the European institutions. The European government has pursued an active and strategically targeted industrial policy, especially with regard to environmental technology. Despite at first lacking international support for Europe's environmental and social agenda, Europe has been reconfirmed as powerful economic and political global player. The European Union champions its socio-economic model world-wide and proactively tackles global challenges. It is also an attractive place for foreign investments. Technology policy and strong support for large-scale European research initiatives leads to more top-down innovations. Policies makers put emphasis on the coordination of policies in order to get the balance right between their strategic objectives in economic, environmental, and social policy.

Policy makers principally aim to introduce cost-effective performance regulation. Apart from direct regulation, governments provide also economic incentives for industry to reduce greenhouse gas emissions and to make production and consumption patterns generally more efficient. Europe also takes a more aggressive approach towards creating business opportunities and export markets for sustainable technology, e.g. through funding large-scale RTD, facilitating industrial standardisation processes and 'soft measures' to help raise the awareness for sustainable production (e.g. labelling, management systems, sustainability accounting and reporting

schemes). Publicly funded RTD targets strategically important technology fields to strengthen Europe's competitive advantage in advanced manufacturing technology.

How will manufacturers respond to the scenario challenges?

Industry priorities in the FutMan scenarios

Manufacturing can draw upon a broad portfolio of responses to cope with the socio-economic environment presented in the scenarios. Their strategies will in any case address the five internal drivers (i.e. key challenges) described in the previous section of the paper. Depending on the specific pressures in the scenarios, industry will consider its responses respectively.

In the FutMan scenario exercise we aimed to sketch the interaction between external and internal drivers and expose the relative priorities with respect to the internal drivers in the scenarios. In one of the FutMan workshops the experts were asked to rank the relative importance of the internal drivers for each scenario by allocating fixed total number of points to the drivers according to their assumed importance for industry in the scenario.⁶ The differences in the allocation patterns of the points to the five internal drivers between the four scenarios can be seen as indicators for industry priorities. Table 2 shows the three factors for each scenario that were received the highest number of points and can therefore be assumed to be the most crucial ones for industry to address in the respective scenarios.

Table 2: Priorities of industry to tackle internal challenges

	Global Economy	Local Standard	Sustainable Times	Focus Europe
Most important challenge	- Anticipate new market needs	- Improve sustainability	- Improve sustainability	- Improve sustainability
Second most important challenge	- Increase supply chain efficiency	- Adopt new technology	- Adopt new technology	- Anticipate new market needs
Third most important challenge	- Create / maintain knowledge	- Create / maintain knowledge	- Increase supply chain efficiency	- Adopt new technology

The low attention of sustainability in the Global Economy scenario and the respectively high attention in all other scenarios is not surprising and rather the consequence of the basic assumptions that underlie the scenarios. What is interesting, though, is the assumed role of technology for industry in the scenarios. In the Global Economy scenario the adoption of new technology was not considered to be a prime concern of manufacturers. Industry actions will rather focus on anticipating and responding to new market requirements, realising productivity gains through the continuous optimisation their value and supply chains⁷, and strengthening the company's knowledge and innovation base. The experts described the Global Economy scenario often as being technologically rather conservative, with little incentives to invest in long-term RTD activities. Technology in the Global Economy scenario was rather seen as something which availability is given and industry buys technology from the shelf.

This is in stark contrast to the experts' assessment of the Local Standard and Sustainable Times scenarios, in which the development and adoption of new technology is assumed to be essential to make the scenarios viable. In the Local Standard scenario this refers mainly to the technological pre-requisites to make regionalised production work, such as mini-plants, new logistics concepts, and distributed plant control and management. The strong inter-linkages with the organisational dimension of innovation is confirmed by the high attention of knowledge crea-

tion in this scenario which mainly refer to the requirement to cope with diverse business environments and high complexity. Less surprising is the high ranking of technology in the Sustainable Times scenario, since the envisaged system changes towards sustainability are dependent on a broad variety of socio-technical breakthroughs.

In the *co-operation scenarios* (i.e. Focus Europe, Sustainable Times) actors pursue *societal visions*. Industry contributes to the realisation of the underlying visions either through focussing on technological innovation, as in Sustainable Times, where policy maker and consumers are supposed to co-operate in providing a receptive environment, or by focusing on the market implications of regulation aimed at the sustainability improvements products and production processes, as portrayed in the Focus Europe scenario. These results confirm that industry acts proactively only upon external stimuli from policy or consumer preferences when it comes to new technology development and adoption.

In contrast, the *go-it-alone scenarios* (i.e. Global Economy, Local Standard) lack any coherent societal visions (above local community levels). The manufacturers' attitude in these scenarios is that *anything-goes* and *anything might happen* in a confusing and conflicting business environment. Industry will mainly raise its overall alertness to external pressures and improve its ability to react swiftly to patchy and constantly changing environments (i.e. acquire and manage knowledge), but aiming mainly for incremental change. However, this tendency creates especially tensions in

the Local Standard scenario, in which radical technological and organisational changes *in manufacturing* seem to be required to make the scenario stable.

The results also show that industry will emphasise radical service innovation (i.e. shift from products to services) more strongly if manufacturers can rely on *clear demand signals* for such services as is the case in the Sustainable Times (stimulated mainly by support from policy makers and consumers) and in the Local Standard scenarios (stimulated mainly by rigidities imposed by policy and local communities). A more flexible approach might be adopted in response to a more *diverse consumer structure* (i.e. high attention paid to the anticipation of new market needs) as portrayed in the *individualist* Global Economy and Focus Europe scenarios.

Discussion of corporate sustainability strategies

In order to discuss the implications of the scenarios for corporate sustainability strategies we suggest to first classify industry's scope for action to improve its corporate sustainability record in three different areas of activities, namely *products & services*, *production processes & supply chain organisation* and *communication with internal and external stakeholders*.

More *sustainable products and services* result of the use of new materials or new technology for products, the reorganisation of logistics to deliver products and services, replacing products with services, the introduction of new, more sustainable business models, or taking responsibility for products over the whole product life-cycle, etc.

Improving production processes and supply chain organisation involve new design practices for products and process (e.g. design for sustainability, design for disassembly), energy conservation and resource efficiency measures, pollution prevention,

recycling, closed-loop production and the de-/centralisation of production facilities, etc.

Instruments to *improve communication with stakeholders* inside and outside the firm include the implementation of management systems, training & education programmes, life-cycle and product impact assessment, sustainability accounting & reporting, and corporate social responsibility, community outreach activities, etc.

In the next step we suggest sets of corporate sustainability actions that can be assumed to be in line with the general orientation and environment in the scenarios. The specific actions companies will take with respect to corporate sustainability are supposed to reflect the socio-economic framework conditions as described below (see Table 3 for summary).

Global Economy: "Tell them that we care anyway!"

In the Global Economy scenario, manufacturers will see few incentives for establishing pro-active corporate sustainability activities that address the environmental record of the firms' products and services. Companies will mainly focus on product & services optimisation guided by customisation and individualisation. However, companies will aim to cut costs and make therefore more efficient use of material resources and energy, in line with their priority to increase supply chain efficiency. The adoption of recycling will be inhibited due to lack of economic incentives and problems in the enforcement of recycling practices. They will support stakeholder communication policies to emphasise that they take their individual responsibility for sustainability issues seriously but will oppose those that would bind them formally or legally. Although the scenario provides a very innovative framework for short-term industrial research as companies focus on strengthening their knowledge base, it impedes long-term risk-assessment and investments in corporate sustainability. System change towards

sustainability would require industry and/or customer initiatives since policy makers limit their actions to strengthen free market forces to sustainability. However, there are few incentives for industry to adoption of non-incremental approaches towards more sustainable production. Corporate social responsibility programmes will be mainly used as a marketing tool. The aim is to show to the public that the company cares, but at the same time it rejects attempts that external stakeholders get more say. The main driver towards sustainability in the scenario is therefore industry's pursuit of increasing efficiency and productivity and to minimise litigation risks.

Local Standard: "Better win the support of the people around us!"

In the Local Standard scenario, firms will strongly adopt corporate social responsibility programme that address local stakeholder concerns. Technological and organisational strategies of companies to achieve sustainability address mainly the regionalisation and miniaturisation of production facilities, as well as the introduction of intelligent logistics solutions and process virtualisation. Industry adopts design strategies that focus on modular, simpler, robust and more sustainable components for their products and services. Intelligent logistics plays a key role in the scenario. Furthermore, industry aims to add value to existing assets and resources. In some regions consumer choice drives manufacturing towards flexible specialisation in production, and cleaner, more ethical production. Strict environmental regulation in some regions leads to the fast adoption of radically new manufacturing approaches to retain production, or otherwise to relocation off-shore or concentration of production in industrial clusters. Industry develops localised alternative energy production systems and acquires experience with the application of small-scale production

techniques and mini-plants. Companies will also aim to exploit innovative approaches in local networks, niches and markets which are likely to become the main driving factors towards sustainability in this scenario.

Sustainable Times: "We create a new world!"

The notion of competitiveness is redefined in the Sustainable Times scenario and includes both environmental and social issues. European manufacturing aims actively to break the link between growth and resource use. Manufacturing companies have increasingly focused on the provision of services rather than selling products and have adapted their product design approaches accordingly. Industry has sought major technological breakthroughs in order to decouple material and energy use from production. Greenhouse gas emissions decrease significantly through introducing renewable energy and bio-resources. Emphasis is given to improve life-cycle impacts by means of improved product design. Given the awareness of the industry on environmental and social effects of production and consumption, the adoption of new technology avoids adverse rebound effects. The Sustainable Times scenario witnesses the emergence of industrial solar energy production. Industry also introduces full lifetime support and maintenance for their products. Radical new business models will be tested (e.g. car manufacturer become mobility provider). Sustainable design and closed loop production are also high on the industry's agenda. Stakeholder communication and the creation of trust between actors is one of the conceptual foundations and drivers for sustainability in the Sustainable Times scenario. Summed up, the main driver towards sustainability in the Sustainable Times scenario is the acceptance of more sustainable business models by consumers.

Focus Europe: “If we can’t avoid the pressure then better turn it into an advantage!”

The main drivers towards sustainability in this scenario are regulation and mission-oriented public sector initiatives. Product and process innovation are orientated towards realising energy savings and making clean production a reality. Advanced recycling concepts and waste minimisation programmes will also gain momentum in this scenario. Companies will introduce internal tools such as environmental management systems, life-cycle analysis (LCA), environmental accounting, and best available technology (BAT) approaches to deal with the complexity of sustainability requirements and opti-

mise their operations accordingly. Policies drive technology development towards lower carbon dioxide-intensity of production. However, the improvement of products and processes happens along existing socio-technical trajectories. Performance regulation favours the improvement of already available technology to make it more efficient rather than promoting radically new products, services and production processes. Since consumer attitudes do not change, the opportunities of new technology can not be fully exploited. The long-term success of the scenario rests on the assumption that European industry’s sustainable products meet (world) market needs.

Table 3: Scenario specific dominant corporate sustainability strategies

	Global Economy	Local Standard	Sustainable Times	Focus Europe
Products & services	<ul style="list-style-type: none"> - Product optimisation - Service optimisation 	<ul style="list-style-type: none"> - Local niche products - Localisation of services - Creating local / sustainable product identities 	<ul style="list-style-type: none"> - Services to replace products - Products and services using renewables - Adaptive products - Total life-cycle product responsibility 	<ul style="list-style-type: none"> - Energy and resource efficient products & services - Extensive product recycling schemes
Production processes & supply chain organisation	<ul style="list-style-type: none"> - Resource & energy efficient production - Process intensification - Risk & liability management - Modular product design - Integrated plant control 	<ul style="list-style-type: none"> - Regionalisation of production & supply infrastructure - Small scale production, mini-plants - Intelligent logistics - Virtual production - Plant intensification 	<ul style="list-style-type: none"> - Design for sustainability - Total life-cycle optimisation & responsibility - Precautionary risk management - Stakeholder involvement 	<ul style="list-style-type: none"> - Waste minimisation - Zero-emission process planning - IPP & BAT adoption - Combined heat-power utilisation - Closed-loop production - Design for recycling
Internal & external stakeholder communication	<ul style="list-style-type: none"> - Green marketing 	<ul style="list-style-type: none"> - Community outreach programmes 	<ul style="list-style-type: none"> - Sustainability accounting - Customer attitudinal change programmes - Corporate transparency 	<ul style="list-style-type: none"> - Environmental Accounting - Life-cycle analysis - Environmental management systems

Conclusions

In this paper we presented four possible socio-economic scenarios for Europe by 2015-2020 and assessed their consequences for sustainable development and corporate sustainability priori-

ties. The main conclusions which can be drawn from the analysis are:

Prospects for Sustainable Development

There seems to be significant differences with regard to the prospects for sustainable industrial

development depending on the future socio-economic and policy environment. The analysis suggests that in the Global Economy scenario sustainability progress will be mainly a second-order effect of industrial activities to raise efficiency of production and realise productivity gains. In the Local Standard scenario 'islands of sustainability' will emerge, however, the feasibility of the economic models and production systems required in this scenario depend on significant technological and organisational breakthrough innovation over the coming fifteen to twenty years. Furthermore, the consequences of a more regionalised industrial structure on regional development and social cohesion in Europe remains a point of discussion. In the Sustainable Times scenario, leaps with regard the reshaping and transformation of production and consumption systems can be expected. However, this process might not necessarily lead to an overall efficient allocation of resources, since the required infrastructure investments are very high and their long-term sustainability impacts should be assessed in more depth. In the Focus Europe scenario, in contrast, industry will mainly follow existing socio-technical innovation trajectories which may rather reinforce current lock-in situations, such as in the fields of materials, energy and transportation.

Pro-active corporate sustainability strategies

Pro-active corporate sustainability approaches of industry will follow different rationales and seek different objectives according to the future socio-economic framework. In the Global Economy scenario companies will proactively adopt corporate sustainability measure principally as a marketing strategy and a means of public relations to prove the responsible company behaviour. However, communication patterns will be mainly organised in a top-down manner rather than two-way. In the Local Stan-

dards scenario, companies seek for corporate sustainability programmes to strengthen their links with local and regional networks and stakeholders. The main aim here is to improve collaboration. In contrast, the Sustainable Times scenario targets the transformation of production and consumption in a more comprehensive sense, and corporate sustainability tools aim for stimulating two-sided communication between stakeholders to facilitate this process. Finally, in the Focus Europe scenario firms are more reactive to policy and economic pressures but aim to transform these pressures into proactive company approaches. Corporate sustainability strategy will therefore focus on the improvement of internal communication practices.

Policy options in support of pro-active Corporate Sustainability

Finally, we would like to present some preliminary ideas about promising policy options in support of corporate sustainability. The analysis of the scenarios suggests that policies should concentrate on those options that either help to avoid undesirable future states to emerge and/or facilitate corporate sustainability in a broad variety of socio-economic environments. The scenarios provide some first indications about such policies. Firstly, the use of market forces and fiscal policy measures such as taxation schemes (e.g. in favour of more sustainable use of energy and resources) seem to have a positive effect on pro-active company behaviour in all scenarios. Secondly, it seems to be essential to pay more attention to users and the demand side of production to foster corporate sustainability. The scenarios suggest that the viability of more sustainable patterns of production and consumption largely depend on user and customer acceptance. Companies will only put emphasis on the development of more sustainable business practices, if they can expect 'sustainable markets' to evolve. In this respect, Europe's diversity and its

sophisticated customer-base can provide good opportunities for the creation of lead market for sustainable products and services. Broad stakeholder involvement also seems to be critical to avoid re-bounce or negative second-order effects of industrial changes. Some of the socio-economic, policy and technology developments sketched in the scenarios have significant impact on sustainability which should be adequately assessed in the decision making and design processes in order to avoid pitfalls. European experience with multi-level governance and complex decision making procedure to effectively coordinate the legitimate interests of various stakeholder groups can serve as a starting point to initiate such broad policy debates. Finally, the exploitation of Europe's competitive advantage in sustainable industrial development can open promising ways to further strengthen pro-active corporate sustainability initiatives in EU manufacturing. Europe's leadership in environmentally friendly technology and strong export orientation of its industry can help champion a specific European approach towards sustainable development in other world regions and to gain long-term industry commitment for a more sustainable European future.

Notes

- ¹ The orientation and contents of this paper (ORA: 63949) cannot be taken as indicating the position of the European Commission or its services. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of the following information.
- ² The paper draws upon the results of the project "The Future of Manufacturing in Europe 2015-2020: The Challenge of Sustainability (FutMan)", funded by the European Commission, DG Research under FP5 and coordinated by IPC-Irish Productivity Centre (project reference: G1MA-CT-2001-00010). As part of the project, IPTS was organizing and managing a scenario building exercise. The final scenario report has been published in the IPTS report series (Geyer et al. 2003).
- ³ The system approach to scenario-based methodologies presented in this paper draws upon Eriksson (forthcoming).

Directions for further research

In particular in relation to the issue of supportive policy options for sustainable development in general, and more specifically for corporate sustainability, the ideas presented in this paper could form the starting point for more comprehensive research and debate. We don't know which scenario (or which combination of certain scenario characteristics) will finally become reality. However, policy makers need to be prepared and develop effective policy approaches for sustainable development for any scenario. Future research is therefore needed to identify and test those policy options for today that are adaptive and robust enough to yield positive results in many potentially foreseeable futures.

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- ⁴ The FutMan scenario exercise focused on four manufacturing sectors – electronic components; measuring, precision and control instruments; basic industrial chemicals; and motor vehicles – and most of the discussions in the workshops were related to these sectors.
- ⁵ A similar approach to structure scenarios was recently used in the UK Foresight programme (DTI 2002). The Foresight Futures 2020 scenarios apply the axis *social values* (individual versus community) and *systems of governance* (autonomy versus interdependence). The main differences to the FutMan scenarios are that we do not assume *individualist* values being opposed to *shared community* values. We rather emphasise the possibility that individuals might develop broader concepts of citizenship, though they need not necessarily being shared by all groups of actors in society. Likewise, as regards the policy dimension, we assume interdependencies of governments in all scenarios. In our case modality of policy not only emphasises the centres of power but also refers to the means to assert positions and settle issues.
- ⁶ In the scenario workshop this ranking exercise was carried out for four case study manufacturing sectors individually. These sectors were electronic components, instrument engineering, basic industrial chemicals, and motor vehicles. The four sectors are supposed to be representative for different areas of manufacturing activities.
- ⁷ Dearing (1999) emphasises the importance of this issues for shaping corporate policies in support of sustainable development.

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