TNO Strategy, Technology and Policy

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TNO report

Science outlook 2003-2013

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General description of trends and drivers
Summary of the sources used.
von Weizsacker et al., 1996;
NIDO/KSI, 2003
OECD:
EU: 6eap, Waste, resources, 5fp, 6fp
Netherlands: NEPP3, NEPP4

2 Theme 1: Natural resources and the environment

2.1 Introduction

This theme focuses on the issues concerning the impact of mankind on the environment and the need mankind has for natural resources. The key element of sustainability is that the ecosystem will provide these natural resources in the long term.

To achieve this equilibrium, the following clusters have been identified through the process of expert review and workshops as being of particular relevance to Defra for the period 2003-2013:

- Transition to renewable raw materials
  Materials use is a major contributor to both environmental impact and resource usage. The shift towards sustainable materials is based on the shift towards renewable materials.
- Transition to sustainable energy
  Energy is the major sources to the greenhouse gasses. To change this new technology and new systems are needed.
- Eco efficient products and processes
  Technology plays a key role in reducing the environmental impact of our society. More knowledge is needed to identify opportunities for the shift towards more eco-efficient products and processes.
- Soil, water and ground
  Soil and water are to important natural resources which are under pressure. What are the major environmental impacts and how can these be reduced?
- Transition to sustainable mobility
  In the last decade mobility multiplied by an order of magnitude. Estimates of future increase shows that this will continue, leading to severe environmental (and economic) problems.
- Waste management and recycling
  Waste is a major burden on our economy – trends indicate that it is likely to continue this growth unless new ways of dealing with this aspect of our economic system are put in place in order to reduce costs and reduce environmental impact.
- Ecosystem integrity
  To maintain the integrity of the ecosystem, more knowledge is needed on the changes within our ecosystem, such as shifts in biodiversity, changes in climate, effects of new technologies on nature and other potential risks to the ecosystem.

Next to these more content oriented issues, further knowledge is needed to make the translation to policy. We identified the following clusters of issues that require research before actions can be defined:

- Transition and system innovation policy
  In many domains the innovations that can more or less individually be developed and implemented are realized. Present issues are more complex and need a multidisciplinary approach. This calls for a new policy approach where little experience is currently available.
- Consumerism and the environment
  Materialism, increasing wealth, individualism, increasing responsibility and other

societal trends lead to a changing position of the consumer to environmental problems. How can the consumer be shifted to sustainable consumption?

- Science, citizenship and policy; finding the connections
  In addition to citizens, science can play a key role in achieving sustainability. How can the gap between science, policy and citizenship be reduced to develop synergy and complementarity between the various efforts?
- Efficient and effective policy instruments
  Science is a crucial first step in the policy cycle. However, the translation to policy instruments is often difficult due to lack of knowledge about efficiency and effectiveness of policy instruments.

In the following paragraphs, these clusters will be described in more detail.

2.2 Transition to renewable resources

Resources are the backbone of the economy. In using resources and transforming them, capital stocks are built up which add to the wealth of the present and future generations. The consequences of this resource use are that the carrying capacity of the ecosystem is endangered, both by production of greenhouse gasses and disturbance of the ecosystem. As material is a major element in our society, forming the basis for many products in every part of the economy, this is an important cluster of issues. This is enhanced by the fact that social-cultural developments are shifting to materialism. Together with the increase of wealth, which leads to more consumption, it is safe to say that our society will ask for more products.[1]

This cluster of issues is mainly the result of technological developments and developing technological trajectories, like the use of biomass energy sources, the hydrogen economy and the use of solar energy as a direct source for materials production. In addition, climate change and its effects, are increasing society's priority to reduce greenhouse emissions, which are still projected to increase.

Looking at this cluster, we identified the following main issues:

- **Biomass as a renewable resource**
  Energy and ,materials policies are focusing increasingly on biomass as a promising solution that can form the basis of the shift towards renewable resources. It can form the basic chemical building block for industry. However, much is unknown and economic, technological and institutional changes are needed to support this transition. The following science needs are important:
  – How sustainable is biomass (e.g. social: North/South divide, economic: productivity, ecological: shifting burdens), including knowledge about ecological impact and land use?
  – What is the socio-economic potential of biomass as a resource for industry?
  – How can biomass be grown and harvested in a sustainable way[2]?
  – How can biomass be converted to chemical building blocks in a sustainable way?
- **Green chemistry**
  The chemical building blocks derived from biomass sources are the raw material input for a wide potential number of other industrial processes. These must be aligned, perhaps in a cascade way. The following science needs are identified:

[1] Recycling and reuse is discussed under the cluster 'Waste management and recycling'
[2] Economic, social, ecological

- What products provide biomass as an economic and ecological building block and what are their material flows?
- What are the possible efficient cascade resource flows (e.g. using entropy evaluation)?
- What pathways are needed to make the shift to renewable resources (to translate the jump into steps)?

- **Alternative materials**
  Next to biomass as a renewable building block, other renewable resources can be used, e.g. alternatives for non-sustainable tropical hardwoods. Here the following science needs are of interest:
  - What are possible biological alternatives for unsustainable materials and what is the potential reduction of environmental impact?
  - What are the pathways to implement these alternatives, including a systems analysis?

2.3 Transition to sustainable energy supply

Next to resources, energy is another backbone of our economy, and one with major consequences for sustainability. The energy system today cannot be described as a sustainable system. Problems exist with greenhouse gases and the achievement of a reliable supply system. To create an economically efficient, sustainable energy supply, in the long-term perspective we need a transition: changes in technology, the economy and social structures.

Many trends have influenced our energy supply system. The globalization of energy markets, liberalization of energy markets, increasing demand because of increasing wealth, increasing technological possibilities (e.g. ICT and households appliances), increase in mobility, demographic developments all have their impact on demand and supply. This means that the energy system cannot fulfil the needs of today and tomorrow. However, the human, technological and economic capital investment in system that has developed in the last century is enormous. The result is a suboptimal system that requires a system change to more sustainability.

The following main issues can be identified:

- **Increase in energy efficiency**
  A traditionally significant issue is the need to still further increase the energy efficiency of products and processes. New technological developments will continue form the basis of this and important issues are:
  - What are new technological developments that can lead to significant reductions in energy use, and what are their likely consequences?
  - The development and implementation of new technologies.
  - How can energy reducing technologies made more cost effective?
  - What are the social, economic and institutional limitations to the implementation of these technologies?
  - In what fields can new products and processes reduce the energy use significantly and what is its potential?
- **Renewable energy**
  Developments in sustainable energy sources form an important trend. Solar energy PV cells, further commercialisation of wind energy, biomass, and aquifer use for

energy storage are examples of these technologies. However, the wider implementation of these alternative throws open further questions:
- What are the economic, ecological potentials of these technologies from a sustainability perspective (shifting the burdens to other environmental compartments)?
- What is the economic potential in the (near) future?
- How can the technologies be implemented socially and institutionally?

- **Clean fossil fuel**
  In the years to come, present estimates indicate that fossil fuel will be available in abundance. Therefore, the exhaustion of fossil fuel is not an issue. However, the use of fossil fuel will lead to climate change and a strategy to use fossil fuel in a clean way must be developed (for example, underground storage of carbon dioxide). Scientific questions remain:
  - What are possible ways of clean usage of fossil fuels?
  - What are potential environmental and economic effects of continued fossil fuel consumption?
  - How can these technologies be used as an intermediate step to a sustainable energy supply system?
- **Modernization of energy chains**
  Our present energy supply system is the result of a long term technological evolution, with dominant technological pathways. Recent concepts like energy decentralisation and industrial ecology can lead to new concepts for energy chains, but many are still in the nascent stages of their implementation. Important scientific needs are:
  - What forms best practice in the liberalisation of the energy market?
  - What are the possible UK sites where energy ecology can be used (integrated planning of energy use)?
  - How and where can energy supply be decentralized in an economic and ecologically feasible way?
  - Where can energy cascading, also using residual heat, result in reduction of energy use?
  - What is the potential of the hydrogen economy for the UK?

2.4 Transition to sustainable transport

Transportation is a core element in society. Several social needs fully depend on a robust transport system, where accessibility, environmental impacts (e.g. emissions and noise) and economic feasibility are in balance. Social needs, such as work and recreation, require a system that provides clean, cheap and quick options for mobility. However, over the last few decades the demand for mobility has increased enormously and the study findings indicate that there will be little foreseeable decline in this growth. This has led and will continue to lead to problems mainly associated with emissions, safety, waste and accessibility issues. Within both the OECD and EU transport in connection with environment is a key priority, as well as several other countries (e.g. Netherlands, Germany and Belgium).

This cluster of issues is the result of several societal trends. It is clear that globalisation is a main driver. This is emphasized by the changes now occurring in the value chain, wherein some distribution elements will disappear, and others will emerge (due to ICT developments, for instance). Also the increasing emphasis on costs and productivity will increasingly stimulate the globalisation of markets. From the social point of view, increasing welfare concerns and provision stimulate the individualism of people.

Together with other changes in values and beliefs, and demographic changes, the movement of people will be further stimulated. Other important technological trends that influence this cluster are the increasing speed of transport, due to technological developments (e.g. the TGV), broadening of supply networks, and ICT developments that enable the spatial scattering of people.

Looking at this cluster, we identified the following main issues:

- **Environmental emissions**
  Environmental problems associated with this cluster are partially the result of the projected increased use of fuel for engines. The shift to cleaner fuels can reduce the environmental impact significantly, but changes to the vehicle can also have positive effects. Important science needs are:
  - More investigation into the potential of technological developments to reduce environmental impact of cars, aircrafts, trains etc. Examples of new technological developments in this area are the fuel cell, light cars, hybrid cars, engine downsizing.
  - The development of cleaner fuels for transport, looking at biomass, clean fossil fuels, hydrogen, etc. What are interesting technologies and what are their potentials? How may agricultural production take up these demands?
  - Behaviour is closely related to the emission of transport, both in the way people drive their car, as in the need for transportation. Better understanding in the relation between behaviour and mobility (e.g. how to use technology to stimulate more sustainable way of driving) and need for mobility (spatial planning) can lead to new policy measures. Also rebound effects are a key issue, where the intended effect is not achieved throught changes in behaviour (e.g. large efficient aircrafts leading to more flights due to reduced prizes).
- **Changing the transport system**
  ICT is changing mobility and community patterns (globalization and the shift between rural and urban communities). The changes in mobility are due to shifts in where people live, work, go for recreation and are educated. On the other hand new concepts for transportation can be identified, such as the modal split, teleshopping, sustainable forms of recreation, tele-education. What effect has technology and other more socially oriented innovations on the transport system? What will be the changes in mobility and efficiency? What are the implications for supply-chains, particularly with respect to food and related transport concerns? The following science needs can be identified:
  - What are possible spatial effects (e.g. shift from urban to rural, decentralizing production), social effects (e.g. have’s and have not’s, individualism), environmental effects (e.g. reduction of movements) and economic effects of ICT developments (e.g. reduction of costs due to productivity increase)?
  - What are interesting new transport concepts, what are their potential, how can they be stimulated? Examples are automated guidance systems, navigational systems, people movers, light rail systems.

Given the above sets of issues, the analysis identified the following as the main research areas likely to impinge upon Defra’s responsibility:

- The first group of research areas is focused on technological development on engines, fuels, transport concepts, new light materials. Examples are transport engineering, aerospace engineering, fuel technology, composites, polymers, metallurgy, process engineering, organic chemistry and electric/electrical engineering.

- The second group of research aims at understanding transport patterns in relation to spatial planning. They also make the translation to policy. Civil engineering, applied economics, commerce, management, tourism and services are to be related to policy and administration.
- The last group of research areas in mainly focused on understanding human behaviour and translating it to technology or policy. In this group are research areas like Behavioural and cognitive sciences (psychology) and other sociology areas.

This cluster should be further developed with the Department of Transport. However, it is also recommended that Defra should have a clear vision on future transport changes and their implication for sustainability. Emphasis should be given to relate the more technological research to 'soft sciences' like economics and human behaviour. Another important aspect is the system level, which calls for a more holistic, multi-disciplinary approach.

2.5 Eco efficient products and processes

Realising eco-efficient products and processes is the complement of the Cluster on "Transition and system innovation policy". The latter Cluster, as described, looks at radical 'Factor 4-10' changes that have to take place at a longer time horizon. Eco-efficiency changes usually look at up to Factor 2 changes at a 5 to 10 year horizon, and in general can be realised with rather traditional policy instruments and approaches. A main point of attention is of course that any long-term 'transition policy' in a given domain should be aligned with an 'eco-efficiency-policy'.

This cluster of issues is the result of promising new or potential technologies, that can lead to new innovations being implemented by individual organisations. ICT, nano technology, biotechnology all provide new concepts that can help make processes and products more efficient from an environmental point of view. However the economic trend towards cost reduction and productivity increase puts stress on the realisation of development and implementation of these innovations. Also individualism shifts business to more incremental and short-term oriented innovations, where the eco-efficient innovations are more medium or long term oriented.

Typical and important issues in this cluster include:
- **Eco-efficiency improvement of processes**
  - Prevention of emissions of diffuse sources. How can these emissions be monitored and new technologies lead to the reduction of these emissions?
  - Identification of the opportunities of ICT, biotechnology and nanotechnology for reduction of environmental impact of industrial processes.
  - Improved monitoring of industrial emissions, to identify major environmental impacts (calamities and normal emissions).
  - (By deduction) potential new sources of contamination and eco-disruption, particularly with regard to biotech and nanotech applications.
- **Eco-efficiency improvements of products (in broad sense)**
  - Development of sustainable product service systems. The combination of products and services can decrease environmental impact due to the shared use and optimal performance enabled by shifting the ownership of goods to a supplier.
  - Reduction of the energy use of household appliances. Analysis of consumer trends, incentives for sustainable consumption, new technologies for household appliances (e.g. gas fired washing machines/ dryers, hotfill, heatpumps etc.). Localisation of energy generation and sourcing.

- Reduction of the environmental impact of housing. New building concepts, use of renewable materials, domotion ???? technology all have a reducing potential to environmental impact. Where and what potential?

2.6 Waste management and recycling

Waste management is a long standing issue for the UK. The analysis indicates that forthcoming EU legislation and policy developments will pose continuously new demands to the UK's waste management system. Examples include:

- The EU landfill directive, that requires upgrading of technical quality of landfills and a ban on landfill of non-treated organic waste;
- Continuously more stringent recycling demands (e.g. for automotive, WEEE, and packaging)

At the more general level, the OECD has indicated that most countries fail to decouple generation of particularly Municipal Solid Waste from the GDP. This trend is worrying and prompted the OECD to classify this as a 'red light' issue that needs targeted policy action in OECD member states (OECD, 2001).

In this Cluster, the main issues and related research questions include:

- **The organisation of waste management: market versus regulation**
- **Prevention of (particularly) Municipal solid waste generation**
- **Using waste as a resource**
  - Improvement of recycling
  - Using non-reusable biomass as feedstock or energy carrier
- **Problems related to specific waste streams**
  - Upgrading hazardous waste management where needed;
  - Underground storage of CO2 (related to the energy transition; solution pathway 'clean fossil fuels';
  - Dumping of ballast water of ocean-going vessels

2.7 Soil, water and underground aquifers(?)

Historically industrial and energy related activities led to soil and water contamination. However, the effects of climate change (e.g. prevalence of longer, hotter summers) are also lead to more frequent and unusual stresses on groundwater supplies.

- Soil and groundwater contamination
  - Economic efficient soil protection and remediation of contaminated sites, versus ecological reduction of risk.
  - Pharmaceuticals and pesticides in groundwater. Effect of sewage sludge to farm land. Closing inorganic cycles used in farming.
  - Environmental impact of landfill. Knowledge about contamination and control.
  - Soil degradation, sediment transportations, erosion, chemical contamination due to upstream/downstream water flows. Land basin management. Understanding the relations between sediment contamination and actual risks to ecosystems.
- Drought
  - What is the potential of integrated water management for the reduction of water usage? Examples are cascade usage, recycling through membranes, heat

    exchanging devices. How can they be developed in an economical feasible way? Should the institutional setting be changed.
  - Future developments in groundwater availability. What are the trends in groundwater usage, for industrial, agricultural and civilian purposes?
- Underground development
  - What are the environmental implications of underground developments, like tunnels and housing facilities? Examples are groundwater flows, environmentally contaminated soil.

2.8 Ecosystem integrity

The ecosystem is a source for many crucial resources that our society needs for survival e.g. minerals, clean air, soil, fuel, land, etc.). It must therefore be sustainable, in order that the carrying capacity of the ecosystem will be strong enough to support society's needs. However, it comes clear that this is at risk and that given patterns of increasing demand, this risk will be accentuated in certain areas. Climate change, loss of biodiversity, soil degradation are all examples that our economy is damaging the ecosystem, leading to perhaps irreversible consequences.

Economic growth, globalisation, and increase in personal wealth (even against a background of continuing widespread global poverty) are major trends that increases the danger to our ecosystem. More consumption, travel, and more people all increase this burden. Technological developments around biotechnology and ICT enhance the danger because of their unknown effects on the environment. Also terrorism and wars are likely to lead to additional burdens and risks.

Important science needs are:
- **Monitoring of environmental impact**
  - What are the mass flows of specific materials with significant environmental impact?
  - What are the effects of the impact on the environment?
  - How to assess the environmental impact of diffuse and chronic emissions?
- **Unnatural mixing of genes and species**
  - What are the risks of GMO on the ecosystem, e.g. the "mixing tank", recombinations, and presence of foreign DNA in habitats?
  - What are the risks of the importation and migration of 'new' species to the UK that can lead to ecosystem unbalance?
- **Biodiversity**
  - How much damage to the ecosystem creates mining and how can it be prevented?
  - What are the effects of habitat fragmentation on biodiversity?
  - What are the trends in biodiversity and how are they related to policy measures?
  - What policy approaches can help to preserve the biodiversity (e.g. farmland management, combination of ecological and economic functions)?
- **Natural and human disasters**
  - What are the trends in climate change and how do they effect spatial functions (housing, working, water, recreation, nature etc.)?
  - Possible implications of bio terrorism
  - Effects of climate change on the economy

2.9 Efficient and effective policy[3]

The objective of policy in a free market economy is to stimulate business, citizens and science there where these actors are not or to slow taking actions to achieve social objectives. The complexity of social problems leads to problems about policy implementation. An efficient and effective policy uses instruments which best fit a specific situation. However, the complexity of systems and issues makes a best fit problematic: What is the effect of this policy instrument?

This difficulty in developing an efficient and effective policy was always the case. However, some trends can be detected that increase these problems further. Globalization and increasing technological possibilities are making the issues more complex. Furthermore, the changing institutional setting of citizens and consumers, together with the changing responsibilities of business in a liberalized market even makes it worse. Trends towards "ecosystem" level responses and policies place further demands on the need to better understand complex systemic dynamics.

To develop an efficient and effective policy, these main issues require attention:

- **Efficiency and effectiveness of policy instruments**
  Funding, legislation/regulation, communication, taxing - all these policy instruments are used to stimulate actors to a specific behaviour. However, it is not clear what the effectiveness of these instruments are. The following scientific questions are relevant:
  - What is the efficiency and effectiveness of these instruments?
  - What factors highly influence their efficiency and effectiveness and how?
  - What is possible and what is not possible?
  - What combination of instruments is possible and effective?
- **The change of citizens, consumers and companies**
  A major factor in the efficiency and effectiveness of policy is the way the actors respond to incentives. However, the institutional setting between companies, government and citizens has changed and is still changing. Corporate responsibility, division between citizen and consumer, self regulation, changing values and beliefs are all examples of this changing setting. Important scientific questions are:
  - How can citizens be motivated efficiently and effectively?
  - What kind of information is needed to address citizens, regarding to information overload?
  - Where is the boundary between business and government from the perspective of responsibility?
  - How can public values be integrated into policy?
- **Globalization versus regionalization**
  The globalization of the economy, the expansion of the EU and the counteraction of nationalism are examples of the increasing tension between regional, national, EU and even global policies (e.g WTO regulation, Kyoto). The following underlying issues are relevant:
  - What is the policy space between UK-national policy and global and EU-policy?
  - How can the different policy levels be aligned?
  - What must be addressed at regional, national and international level?
  - What are the consequences of international policies (WTO, EU, Kyoto, etc.) on UK policy?

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[3] This cluster of issues is not only relevant to the environmental theme, but also is applicable to other themes.

- How can regional policy best serve national policy and vice versa?

- **Integration of policy**
  OECD reports show that there is an increasing issue due to system failures. Policies are counteractive and there are inherent systemic failures[4] within the social-economic system that are not addressed. New policy and policy integration is needed to increase the efficiency and effectiveness of policy making. The following scientific issues are relevant:
  - Which policy domains are counter productive and need alignment?
  - What are important systemic failures within our society that are frustrating the efficiency and effectiveness of environmental policy?
  - How can environmental cost be integrated into the economic system?

2.10 Transition and system innovation policy

It has become almost a platitude that radical innovations are needed to prevent the possibility that nature will break down under the combined pressure of population growth and the growth in per capita wealth. In the next 50 years, the world population will rise from approximately 6 to 9 billion people. The wealth per capita in areas like China, India and Africa still needs to grow by a factor 5 or more only to come close to the prosperity that Japan, Western Europe and the US currently share. This factor in economic growth will lead to a corresponding factor increase in environmental pressure, if there is no change in the organization of production and consumption patterns. Or, to take a different perspective, if the environmental pressure is to be maintained at present levels, a similar magnitude of improvement in the fulfilment of needs should be reached.

This challenge cannot be countered by optimization of existing socio-technical structures (e.g. making cars more fuel-efficient), or singular innovations that change elements of production-consumption chains (e.g. implementing a material recycling system for end of life vehicles). Most authors now agree that *system innovations* are needed. Such innovations in principle focus on societal needs or functions (e.g. the need of current office workers to be in contact in a variety of circumstances with others) and the systems that determine how these functions are fulfilled (our organization of work, our way of spatial planning, resulting in the need for commuting often considerable distances, via an infrastructure dominated by car transport). They have the largest scope for change and hence reduction of environmental pressure, but also need the alignment of activities of a large number of actors in society during a considerable time period. The time horizon of such changes, or 'Transitions' is often decades.

In other sections on this Theme, various Clusters are described that deal with transitions in specific domains (e.g. mobility, energy, resources). This generic Cluster on system innovation focuses on *generic* competence development and research questions related to Transition and system innovation policy. Main issues in this cluster are (see also the detailed Issue list and Research field list in the Annexes to this report):

- **Understanding the process of system innovations:**
  - Overcoming fragmentation in science efforts (inter- and interdisciplinary research)

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[4] In contrast with market failures [OECD, 1998]

  - Questions in terms of contents: What are the three or four most relevant paradigms that describe the process of radical sustainable innovation? What are the main drivers for such innovations? What determines which drivers dominate in which situation
- **Understanding governance models and policy instruments that support and can channel system innovations**
  - Understanding the effects of environmental policy on innovation;
  - Sustainable procurement as a policy tool;
  - Balancing liberalism and market control
  - International co-operation
  - New interactive governance models (e.g. Arena processes, etc.)5.
- **Understanding the role of business in system innovations**
  - Sustainable product-service business models;
  - Economic effects of environmental actions
  - Contribution of financial services to sustainable development
  - Interaction of scientific research with business

2.11 Science, citizenship and policy; finding the connections

Another generic Cluster concerns questions how science, policy and citizens can best interact. In the traditional view on science, these three domains are quite well separated. In a democratic system, citizens elect politicians and via this process delegate decision making on normative issues. Science for policy making should provide all relevant input to a decision making process as far as not normative, i.e. providing ‘hard facts’, providing ‘uncertainty ranges’ and indicating which elements are ‘value choices’. Science for stimulating innovation is described via a traditional ‘push’ model (i.e. via fundamental research, applied research and market penetration/diffusion new technologies are embedded in society).

In the current network societies this traditional picture of how science, citizens and policy interact becomes rapidly obsolete. Values and facts appear to be more difficult to separate than usually thought, as shown in debates on GMOs, the precautionary principle, etc. Innovation becomes more a matter of interaction of business processes, markets, and science in a direct form, than the linear approach depicted above.

From the list of issues shown in the Annex, against this background the following Main issues and underlying research needs can be distinguished:

- **Developing new modes of involving citizens in science-related policy decisions**
  - Articulation of public values (for instance, concerning eco-choice, environmental quality-of-life questions) and developments into policy
  - Public acceptance of science and research
- **Key domains where 1) has to be applied:**
  - Food safety
  - GMOs
  - Risks related to air transport
- **Understanding the pressures and demands to DEFRA**

[5] Not mentioned in the annex but included on the basis of general expertise of the authors.

2.12 Consumerism and the environment

Ultimately, all environmental pressure is caused by consumer demand. Consumers are the demand factor for the economic system, and consumer behaviour determines the amount and form of product-services that are produced by the economic system. Indeed, to some extent consumers also have an influence on *how* such product-services are produced (e.g. by showing preferences for specifically labelled products like FSC-wood, ‘Organic’ cotton, etc.).

Hence, given that trends indicate an increase in this factor over the foresseable time horizon, how to organise and stimulate more sustainable consumer behaviour is a key question of relevance for DEFRA in the next decade – we refer in this respect as well to UNEP’s 10 year Framework of programmes on Sustainable Consumption and Production.

Under this Cluster, the following Main issues play a role (see also the detailed issue list in the Annex to this report):

- **‘Getting the prices right’**
  - Realising honesty (and clarity) in environmental costs;
  - Development of a sustainable tax system
- **Making information about sustainable products transparent for consumers**
  - (Labelling of) alternative materials for tropical wood, and other sustainably produced agricultural products and materials
  - (Labelling for) sustainable tourism
  - Information overload versus exercise of choice
- **Stimulating business models that encourage sustainable consumption**
  - Sustainable product service systems
  - Organisation of consumer demand for sustainable consumption and production