Integrated EST framework (EST-Frame)

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Small or medium-scale focused research project.

EST-Frame deliverable 1.2: The current and future context for EST analysis

Erik Thorstensen, Oslo and Akershus University College

Philip Boucher, University of Nottingham

Ellen-Marie Forsberg, Oslo and Akershus University College

Erik de Bakker, LEI Wageningen UR

Marc-Jeroen Bogaardt, LEI Wageningen UR

Nina Bryndum, The Danish Board of Technology

Davy van Doren, Fraunhofer ISI

Nils Heyen, Fraunhofer ISI

Kamilla Kjølberg, Oslo and Akershus University College

Lars Klüver, The Danish Board of Technology

Ralf Lindner, Fraunhofer ISI

Kate Millar, University of Nottingham

Rasmus Øjvind Nielsen, The Danish Board of Technology

EST-Frame

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SEVENTH FRAMEWORK PROGRAMME

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Preface

This deliverable is produced as a component of the research work conducted within a European research project on integrated assessment of emerging science and technologies (EST-Frame). It builds on work across four case studies, specifically

i) nanotechnology in food,
ii) synthetic biology,
iii) biofuels, and
iv) cloud computing.

These case studies provide an overview of how technologies have been assessed nationally (respectively in the Netherlands, Germany, the UK and Denmark) and at an EU level. In addition, this work builds on studies of different assessment domains (viz. risk assessment, ethical assessment, foresight, technology assessment (TA), economic assessment and impact assessment).

Across all these studies, a number of individual assessments were reviewed using a standardised protocol. The results from these studies are published in four individual case study reports and an additional report on the assessment domains (deliverable 1.1). These reports are published as deliverables on the project website (www.estframe.net).

This report (deliverable 1.2) aims to add an analytic dimension to these studies by exploring how policy trends may influence on assessment of emerging science and technologies and how an integrated framework might be affected by and respond to these trends. Further details on the evolving EST-Frame integrated framework are outlined in a report (deliverable 1.3) which is also available on the project website (www.estframe.net).

An earlier version of this report was submitted to the European Commission June 30th 2013. The current version is slightly updated and edited after further work was carried out on the material for the publication of an article for a special issue of Science and Public Policy on results from the EST-Frame project: Van Doren, D., Forsberg, E-M. and Lindner, R. 2014. How are EST-assessments responding to a dynamic environment? Evidence from four techno-scientific domains. Science and Public Policy, 41: 317-331.

If you have any comments on or questions regarding this report please contact the project coordinator:

Dr Ellen-Marie Forsberg (Ellenmarie.Forsberg@hioa.no)

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0. Executive summary and recommendations for policy makers

Technology advising takes place in larger societal contexts. These contexts can be understood as influenced by some significant mega/macro trends (Slaughter 1993), as well as a variety of trends and developments at a meso and micro level. Assessment of emerging science and technologies must respond to such trends in order to be well targeted and policy relevant.

In this document the macro trends are identified and analysed, with the most important aspects examined in more detail in order to consider the implications for technology advisory practices.

In this deliverable the trends and contextual factors that have been identified as the most significant are those that are:

a) Important to consider when designing, carrying out and evaluating assessments; and
b) Important for developing a framework for integrated assessment that is capable of being responsive to such developments.

The trends have been profiled as:

1. Liberalisation and globalisation
2. New governance networks
3. Public-private partnerships (PPPs)
4. Citizen empowerment and public deliberation
5. Rapid technological change
6. Focus on sustainability and climate change
7. Economic change
8. Quantification
9. Policy integration as a response to the identified trends

In particular this analysis has examined whether or how the identified assessments (for example in the case studies):

a) discuss the effect of the trends on technology governance
b) adapt their methods to the trends in order to have more impact on technology governance
c) are transparent about their assumptions regarding the future and how the trends influence any of the topics they address (for example, ethical issues, economic projections, technology development, etc.)

The main lessons and recommendations that have emerged from this work for policy makers are:

1. Greater levels of market liberalisation and public-private partnerships (PPP) seem to indicate increased importance of economic assessments in decision-making. However, economic assessments are not dominating any of the chosen case studies, and PPPs are hardly mentioned. If it is the case that liberalisation is an important contextual factor then the

effects of market liberalisation on responsible technology governance should be discussed more widely. Moreover, the economic assessments that underlie policy on PPPs should become more transparent and scrutinised as part of the assessments in EST fields. As liberalisation potentially affects the boundaries of technology governance, we recommend that assessments discuss this reflectively to a larger extent.

2. New governance networks, especially on an international level, are being considered in assessments. However, because of the global character of the current grand societal challenges, there should be increased infrastructure and competence building for assessment at a global level.
3. Citizen empowerment has typically been an important element within TA, but impact assessments also include some wider involvement. We recommend that more systematic infrastructure or instruments for the involvement of lay people and a broader range of stakeholders in all assessments is developed. This also means empowering potentially marginal or socio-economic weaker groups (for instance consumer and societal organisations without much financial resources) thus facilitating participation. We also recommend developing standards for transparency in such involvement processes, in order to be able to assess the nature and quality of the involvement.
4. Rapid technological change implies that significant uncertainties may result, both with regard to environmental and human health risks, and with regard to societal and economic impacts. These uncertainties must be characterised and applying the precautionary principle must be considered. Moreover, such rapid change also affects important societal values. These must be considered and appropriately addressed in an anticipatory way, so that societal, value based technology governance can be carried out at an appropriate early stage.
5. Sustainability – and especially its social pillar - can be better operationalised. Sustainability needs to be addressed as an integrative concept, and not split into separate 'silo' assessments that are not integrated. If sustainability is to be an important policy goal, better tools for integration of knowledge need to be developed. Even at a time of 'economic crises', the balance of ecological, economic and social concerns need to be considered, so that unsustainable measures are not used and embedded for short-term gains in the European economy. In such balancing, quantification has a place, but it must be scrutinised and placed within a wider perspective.
6. Transparency of assessments is crucial for ensuring policy integration. Insufficient transparency about assumptions, methods and the practical aspects of the assessment process comparability is likely to reduce the value and impact of the assessment. Best assessment practices need to be clearly defined and disseminated.

Overall, we have found that the policy trends may have significant impact both on the development of EST, the possibilities for responsible governance of EST and the setups and practices of EST assessment. This merits devoting much more attention to the trends in EST assessment in general and especially in assessment processes that intend to integrate the assessment evidence base in a field into practical, multi-dimensional policy recommendations.

1. Introduction

This is a report on trends that affect technology assessment and governance. The assumption in the report is that technology advising takes place in a larger societal context characterised by some significant mega/macro trends (Slaughter 1993), as well as a variety of trends and developments at a meso and micro level. A trend is here understood as a contextual force and driver of a social, political, technological, governmental or natural character. From the literature trends are a defined as a collage of present circumstances that extend current patterns into the future. Trend analysis grants societies "future vision" (Cornish, 2004, Chapter 6, Section 5, para. 10) allowing populations to be proactive in response to future events. Included in a definition of a trend are three commonalities that trends share. First, trends are a complex synthesis of information from a wide variety of fields. Second, trends all use pattern identification and recognition to make predictions when talking about the future. Finally, trends use time frames to evaluate their evolution. In this report we build on trends identified by other consortia; we have not performed our own trends research. For the practical purposes in the EST-Frame we understand trends as contextual forces and drivers of a social, political, technological, governmental or natural character.

In the report we have identified seven trends that shape society in general, and an additional two that influence contemporary technology assessment and governance. Moreover, we present some important responses to these trends; responses that in themselves amount to significant contextual factors for EST assessment. Technology assessment and governance must respond to such trends in order to be well targeted and policy relevant, and to facilitate responsible technology governance. Without a realistic analysis of contextual factors influencing technology governance options, responsible technology policy is not possible.

This does not mean that every assessment needs to explicitly relate to all trends, but that there is a need to include such assessments in the body of assessments in a field. Moreover, assessments with an anticipatory nature and an intention to inform policy will make some assumptions about the governance context. These can be explicit and explicitly justified, or they can be assumed without further mentioning. Assessments that are reflective about their assumptions will be able to position their advice in a more robust way. Assessments that are not explicit about their description of the governance context may still have relevant conclusions, but may be more vulnerable in their situation description. Moreover, when comparing assessments transparency on the assumptions in the assessments – also about the contextual trends they assume – is of great importance. Assessments need to be transparent about their assumptions about the future and how the trends influence the topics they address (ethical issues, economic projections, technology developments, etc.).

In this report we set out some of the trends that we see as most relevant for assessment of emerging science and technologies and we present some analyses of how assessments relate to these. We will

also discuss what implications the trends may have on the organisation and work forms in the different advisory domains (risk assessment, ethical assessment, etc.)[1].

An important goal of the EST-Frame project is to develop an integrated framework for assessment of emerging science and technologies. Scientific development, innovation policies, and governance and assessment practices are part of a larger societal context characterised by ideological and political trends. In order for an integrated framework to be robust, it needs to take shifting advisory contexts into account. Moreover, the trends and responses we have identified have direct impacts on the question of integration in assessment. In this document we analyse the trends and responses we identified as most important and consider their implications for technology advisory practices and integrated assessment.

The structure of the report is as follows. Chapter 2 describes how the trends were identified. In chapter 3 the trends are first briefly described and justified and then implications for technology policy, governance and assessment are discussed. We have been interested in the following main questions: How might trends in this dimension influence the importance of the different advisory domains? How might trends in this dimension influence on methodological choices (such as impartiality, participation, explicit values and other dimensions described as core process characteristics in the process characterisation table)? How can assessments integrate this trend? How might trends in this dimension impact on technology governance? Can we recognise these trends in the assessments we have reviewed in the project; i.e. does it seem like trends along this dimension are already affecting assessment choices? We have also tried to make qualified hypotheses about the observed relations (or lack of such) between the trends and assessment. Chapter 3 also discusses policy integration as a current response to the influences of the trends.

As mentioned, an important goal in EST-Frame is to determine the need for more integrated assessment of emerging science and technologies (EST), and to suggest options for integration in light of the empirical and analytical studies in the project. Chapter 4 therefore contains a discussion of what our trends analysis implies for the potential for and design of an integrated assessment framework. Chapter 4 also summarises the main conclusions and provide overall recommendations to policy makers.

1 See EST-Frame deliverable 1.1 for a discussion of the concept of an advisory domain.

2. Identification of Trends

Identifying trends requires a great empirical and analytical effort, often involving discussion groups with a number of experts and stakeholders (cf. e.g. the ESPAS: Global trends 2030). This is beyond the scope of the EST-Frame project and here we draw upon existing resources to identify relevant trends. Seven reports stand out as particularly relevant for technology assessment and governance:

- Ernst and Young (2011) Tracking global trends. How six key developments are shaping the business world
- EEA (European Environment Agency) (2011) The European environment — state and outlook 2010: assessment of global megatrends
- European Commission Joint Research Centre, Institute for Prospective Technological Studies (2010) Facing the future: time for the EU to meet global challenges
- ESPAS (European Strategy and Policy Analysis System) 2012: Global trends 2030 –Citizens in an Interconnected and Polycentric World
- OECD (2001) Governance in the 21st Century
- ICSU (2011) ICSU Foresight Analysis Report 1: International science in 2031 – exploratory scenarios.
- EC DG Research and Innovation (2012) Global Europe 2050

We identified these reports by internet searches and by literature references in other reports. We deliberately searched for reports that were developed in a policy context, and not simply in a research project. This was to ensure policy relevance. Moreover, several of these reports involved a larger number of stakeholders and other actors in developing their trends analysis, which is assumed to increase their practical relevance and stakeholder validity.

We started the analysis by mapping all trends mentioned in the reports. When subtracting the trends that were only mentioned by a single report we ended up with the trends presented in a table in annex 1. The overall trends described in the reports were often formulated in a general introduction and the more specific trends were described under separate points. It would be far too ambitious to include all specific trends mentioned in the seven reports, therefore only the headlines are included in the annex 1 table. The headlines often included several aspects. We therefore had to make judgements about what points should be clustered together under an overall headline (‘new governance networks’, for instance). The clustering in the annex was considered purposeful.

We also screened the trends on two criteria. In order to be included for further analysis the trend should be

a) Important to consider when designing, carrying out and evaluating EST assessments; and
b) Important for developing a framework for integrated assessment that is capable of being responsive to such developments.

Table 1 shows the list of trends, including the number of times the trend is mentioned in the seven reports listed above and the research teams' judgment on the relevance of the trend for technology governance.

Trend (number of mentions in trend analyses)	Generic relevance for Technology Appraisal and Governance
New governance networks (5)	Highly important
Rapid technological change (4)	Highly important
Increased focus on sustainability (4)	Highly important
Citizen empowerment and democratisation (3)	Highly important
Liberalisation and (economic) globalisation (3)	Highly important
Policy fragmentation/integration (3)	Highly important
Resource scarcity (3)	Lower importance
Urbanisation (2)	Lower importance
Diseases (2)	Lower importance
Demographic change (2)	Lower importance
Global human community (2)	Lower importance
Economic change (2)	Highly important
Climate change (2)	Highly important
Environmental change (2)	Lower importance

Table 1: Trends with number of mentions in trend analyses and relevance for technology appraisal and governance.

We decided not to include those of lower importance as they were not considered sufficiently important for the assessment of emerging technologies in general. This does not mean that they are not important trends. It only means that they do not intrinsically influence technology governance and assessment. Indeed, they may be relevant in assessment and governance of specific technology issues, but not as generic and direct influences on any development and governance of EST.

When we discussed the list in the project and with the advisory board, it was decided to include also quantification and public-private partnerships as specific trends relevant to technology appraisal, but not general enough to make it to the overall reports on megatrends.

The final list of trends studied in the project was therefore:

1. New governance networks
2. Liberalisation and globalisation
3. Public-private partnerships
4. Citizen empowerment and public deliberation
5. Rapid technological change
6. Increased focus on sustainability and climate change
7. Economic change
8. Quantification
9. Policy integration as a response to the identified trends

Three trends, liberalisation and globalisation, new governance networks and public-private partnerships, can be regarded as aspects of the same mega-trend where the dominant movement is away from the national government and towards super- and sub-national public-private governance, but we chose to analyse them separately as they had slightly different implications for technology appraisal and governance. We combined "sustainability" and "climate change" into one trend because climate change is one of the most important issues of the environmental pillar of sustainability, and in itself a driver for an increased focus on sustainability.

It should be clear that the table above represents our interpretation of the points in these reports. The reports presented the trends they identified (sometimes a larger number of trends) in slightly different ways. For our purposes it was necessary to structure their individual points into common categories which we could then apply in our analysis. Other researchers may have categorised the contents of these reports in other ways. However, for our purposes it was more important to capture what we believe are the most important factors rather than securing strict justificatory relations to other policy reports. From discussing our resulting categories in the project consortium and with the project advisory committee we feel confident that the selection of trends is a useful one, though not necessarily entirely complete.

In the study we did not apply a strict definition of 'trend'. The reports we used as our basis applied different terminologies or did not define their understanding of a trend. For the purposes of the EST-Frame project, with its focus on practical advice to assessment communities and policy makers, it has been considered sufficient to use the term in a broad sense. For the practical purposes in the EST-Frame we understand trends as contextual forces and drivers of a social, political, technological, governmental or natural character.

The identified trends are assumed to already affect our society. There might be societal shifts that change the importance of these trends. However, most trends reports anticipate that these trends will continue to influence society in the short to medium term. The trends will be relevant as factors in many EST assessments and they may have implications with respect to how assessments are conceptualised and the choice of procedures and techniques for technology advice. We explore in this deliverable to what extent these trends currently appear to affect EST assessment, and to what extent one might expect (further) adaptations to the trends in the years to come. This will be

discussed under each trend, using material from the EST-Frame case and domain studies. See EST-Frame deliverable 1.1 for the results of the domain studies and for more information on the methods used in this project. See annex 3 in the same deliverable for an overview of the aggregated findings from the project's domain studies, and the case study reports for the aggregated findings from the project's case studies. All are available at www.estframe.net. In this report we use this information as the basis for our discussions of findings in the project.

The discussion of the trends in this report is based on content from the seven trend reports above, other literature review, as well as findings from the EST-Frame case and domain studies. In the EST-Frame analytic protocol developed early in the project, we included contextual and other characteristics held prima facie to yield relevant information for the trends study. Several dimensions in the process characterisation table were used in the trends study, including information on the assessing organisation, the treatment of scientific uncertainties, the inclusion of explicit ethics/values, inclusion of lay people, as well as specific questions regarding assumption of and reflection on selected 'core contextual dimensions' corresponding to important dimensions in the trends study. This was information on the assessments' assumption of and reflection on internationalisation, liberalisation, public-private partnerships (PPPs), policy integration, consumer acceptance and sustainability. 101 assessment reviews formed the basis of this empirical input. The assessment reviews provided evidence on the topic of whether or how the identified assessments:

a) discuss the effect of the trends on technology governance
b) adapt their methods to the trends in order to have more impact on technology governance
c) are transparent about their assumptions regarding the future and how the trends influence any of the topics they address (for example, ethical issues, economic projections, technology development, etc.)

The studies were mostly qualitative discussions, but to some extent quantitative data were gathered. To the extent that the findings from these studies were regarded as informative they have been included in the discussions in this report. The chapters below make varying use of this information.

3. Main trends and policy environment affecting advice on EST

3.1. Liberalisation and Globalisation

Liberalisation and globalisation are strongly related to the emergence of new governance networks (3.2) and public-private partnerships (3.3). These latter trends may even been seen as more concrete materialisations of or societal responses to liberalisation and globalisation as a mega-trend. Together these trends flag a movement away from the national government and towards super- and subnational public-private governance. Liberalisation and globalisation are not the same thing: whereas globalisation refers to the process of international integration arising from the global interchange of people, products and ideas, liberalisation more strictly focuses on the relaxation of government restrictions in global economic and trade policies. Liberalisation in that sense is also referred to as economic globalisation as it has picked up since neoliberal policies became dominant in the post-cold war era that started in the early 1990s (O'Sullivan & Sheffrin, 2001; Ritzer, 2011).

Liberalisation and globalisation viewed together constitute an important trend because they impact on the possibility of democratic steering or governance of technology. In a liberalised and globalised world more power is given to the free market and national governments have less power to influence the production and marketing of products. National governments may still have the capacity to set their own research and innovation agendas but fewer possibilities for rejecting products on normative grounds. The WTO's role in the European moratorium on GMOs is a good example of the effect of liberalised trade policies on societal technology choices (Winickoff et al. 2005). This implies that liberalisation and globalisation is an important trend to consider in assessments of emerging science and technologies.

Liberalisation or economic globalisation is the increasing economic interdependence of national economies across the world through a rapid increase in cross-border movement of goods, services, technologies and capital. It is centered on the diminution of international trade regulations as well as tariffs, taxes and other impediments that suppress global trade. Liberalisation is the process of increasing economic integration between countries, leading to the emergence of a global marketplace or a single world market. Since especially the early 1990s, nations have increasingly reduced tariff barriers and currency restrictions on international trade. Other barriers, however, that may be equally effective in hindering trade, include import quotas, taxes and diverse means of subsidising domestic industries and still play an important role on the global marketplace (Joshi 2009).

Globalisation refers to the widening, deepening and speeding up of global interconnection and includes economic, social, mercantile, cultural, political, and human connections and contents. Held et al. (1999, 15) provide the following more elaborated definition:

> *Globalization can be located on a continuum with the local, national and regional. At one end of the continuum lie social and economic relations and networks which are organized on a local and/or national basis; at the other end lie social and economic relations and networks which crystallize on the wider scale of regional and global interactions. Globalization can be taken to refer to those spatial-temporal processes of change which underpin a transformation in the organization of human affairs by linking together and expanding human activity across regions and continents.*

Of course, liberalisation and globalisation are not without counter tendencies like protectionism, nationalism and reinforced state control. Nevertheless, there seems to be a consensus in the literature that private (or non-state) actors need to be taken into account in governance systems for a liberalised and globalised world (ESPAS 2012, 139—142). The global co-operation will need to take place on several levels: the old inter-state agreements will lose their relevance since they must find their place within in an increasing number of transnational structures that will appear. These will all have to accommodate for new forms of trade organisation and common stewardship of resource and sustainability issues.

One important interconnection between liberalisation and globalisation is the rise of new states as economic drivers, such as the BRIC-states (Brazil, Russia, India and China). One important cause for these economies increased competitive capacity is a world trade system where national and/or regional barriers to international trade have been reduced. In this liberalised system, the force of a state in the international system depends on its ability to produce, transport and sell goods on more favourable conditions than its competitors.

Such changes in the balances between former and newer economic powers has already created new forms of globalised governance as can be seen in the G8, G8+5 and G20 structures (EEA 2011, 92).[2]

In connection with supra-national governance networks private actors are a potential resource that can influence governments to reach agreements and to assure that such agreements are uphold and sanctioned, since breach of agreements will affect the public and then NGOs might react. Such breaches will tamper with the trade conditions and then the business world will react. The European Strategy and Policy Analysis System concludes that: 'Innovative formats for cooperation will not be an alternative to well-functioning, rule-based multilateral institutions, delivering public goods such as decisions with universal legitimacy and norms creating predictable and verifiable patterns of reciprocal action.' (ESPAS 2012, 147)

2 G8 is composed of the heads of state of France, United States, United Kingdom, Russia, Germany, Japan, Italy, and Canada. G8+5 also include Brazil, China, India, Mexico, and South Africa. G20 is a group of national banks and ministers of finance and the members are Argentina, Australia, Brazil, Canada, France, India, Indonesia, Italy, Japan, China, Mexico, Russia, Saudi-Arabia, United Kingdom, South Africa, South Korea, Turkey, Germany, USA and the EU.

Governance within a situation of liberalisation and globalisation can involve strengthening supra-national governance mechanisms (see New governance networks) or rely on market driven mechanisms. This will importantly involve industry initiated standards and voluntary schemes, and enabling consumer choice, for instance by labelling. The European Environment Agency writes that such soft regulation will become an important trend in itself and explicitly mentions the International Organization for Standardization (ISO) as an example of the development of voluntary codes and standards that will continue to develop outside of the formal governance context of states and inter-state relations (EEA 2011, 91—93).

The most important instruments developed by ISO is the ISO Guidance on Social Responsibility. ISO 26 000 is a guidance document, and not a certifiable standard. As such it differs from the alternative standard on social accountability (SA 8 000), but is equal to the UN's Global Compact. It can be used by all kinds of organisations – public and private, small, medium sized and large — and it is a framework that can be adapted to the context and needs of the organisation. It consists of 7 basic principles of social responsibility: accountability, transparency, ethical behaviour, respect for stakeholder interests, respect for the rule of law, respect for international norms of behaviour and respect for human rights.

When using ISO 26 000 organisations need in addition to analyse its activities with respect to seven core subjects: organisational governance, human rights, labour practices, the environment, fair operating practices, consumer issues and community involvement and development. The corporation is to involve key stakeholders in the assessment of what specific issues are relevant related to these core subjects, and what issues the organisation should prioritise to improve. Ideally there is an annual audit of the organisation's performance on these issues, and a review and adjustment of specific social responsibility goals of the organisation. This provides an assessment scheme for EST where assessments are done by the organisations themselves, rather than by outside agents, such as public advisory committees. In the nano context there is also an initiative in the European standardisation organisation (CEN) on responsible nanodevelopment (CEN TC 352), that can be used for similar assessments in the nano field.

International standardisation organisations are also important for the development of labelling schemes. ISO ISO/PRF TS 13830 is developing a 'Guidance on the labelling of manufactured nano-objects and products containing manufactured nano-objects'. Again, a number of consultancies will here be assessing the organisations that want to conform to the guidance. So, an implication of liberalisation is also a shift of balancing from public advisory bodies to private assessment companies. A potential challenge here is that these private assessment companies will have much stronger incentives to be positive to the market logic and may also by more favourably inclined (in terms of securing future business) when doing assessments for the customers.

It is further suggested that states will increasingly create state-owned corporations and investment companies in order to influence and improve their competiveness, and that global public-private partnerships will become more influential and cover more areas than today. Examples of such areas are law enforcement, poverty reduction and development aid (Ernst & Young 2011, 16; EEA 2011,

97). Within a public-private partnership perspective there is no assumption that the private partners need to be recruited within the country that offers the partnership. Indeed, within the perspective of economic globalisation there should be equal competition for supplying the private service on a global scale.

In this situation the former division lines between domestic and foreign policies, on the one hand, and government and private interest and finances, on the other hand, will increasingly become vague. Valaskakis comments upon this situation:

> *The indiscriminate and accelerated migration of decision making from the one-person = one-vote democratic formula to the one-dollar = one-vote market formula creates a danger of serious democratic deficits, increasingly deplored by many. (Valaskakis 2001, 62—63)*

Also other trend reports suggest that there are obstacles to a liberalised and globally integrated future. ESPAS says that economic liberalism might be challenged by other ideologies because of its unsustainable pedigree. The EEA says that the citizens must be active and demand accountability from involvements in global governance and follow attentively the implementation of global means in domestic settings.

The image that stands out when discussing liberalisation and globalisation is that private actors will have a central role in future global governance of science and technologies.

Implications of this trend

Liberalisation and globalisation have a characteristic impact on science and technology development. Here an approach has gained importance with an emphasis on thinking in terms of a knowledge economy. Knowledge then becomes qualified as instrumental to economic progress and competitive power. Liberalisation and globalisation have thus fuelled a vision on science and technology development that emphasises the contribution of knowledge to economics and entrepreneurship. Consequently, knowledge production has developed organisation forms in which corporate representatives gain a role in setting the research and innovation agenda. The pursuit of knowledge is no longer a goal in itself but becomes instrumental towards economic growth (Felt & Wynne, 2007).

Limitations of this trend are easy to identify. The exclusive focus of research and innovation on economic profit is problematic, since measuring the performance of research and innovation merely in terms of its contribution to cost reduction in production processes, market growth for products or profitability on the foreign market is one sighted. Moreover, liberalisation or economic globalisation means increased dependency on foreign markets. Such a dependency can imply an intensified national (regional) focus on economic competitiveness as a factor in assessing emerging science and technologies. Where commercial interests are increasingly present, there might be a shift from the democratic disclosure of procedures and results towards increasing competitive non-disclosure of information. Such a shift would reduce the potential of assessments to enhance the overall public benefit of emerging science and technologies. This amounts to a practical problem, for instance in Norwegian assessments of the sustainability of each notification of market release of GMOs to the

Norwegian market (according to the Norwegian Gene Technology Act). The companies simply do not provide the necessary information for carrying out the assessments (Bioteknologinemnda 2013).

Assessment domains with the ability to deliver information for assessing market based options may become more prominent than ones that cannot. More specifically, this policy trend could benefit sub-sections of advisory domains resting on theoretical foundations positively attuned to the underlying current of liberalisation. For example, neo-liberal economic assessment would be stronger positioned amidst other advisory domains, just as innovation-oriented technology assessment would grow more important than assessments with a more cautious approach to science and technology in society. Whatever approach is taken it is, within such market based logic, essential that the economic assessments are qualitatively good. For a market logic to function without leading to an environmental disaster externalities must be appropriately valued so as to influence the cost-benefit ratio of different technological applications. Economic assessments should therefore be subject to much more scrutiny. For this to take place there must be limits to secrecy. This also holds for certification schemes, as mentioned above. More transparency in assessments in general must be required. On the other hand, globalisation, with broader than economic connotations, may offer the potential for more inclusive assessments, especially given the increasingly international scale of chains of production and consumption. Where assessments are also adopted on an international scale, they may be better equipped to capture costs and benefits of technologies more comprehensively.

Liberalisation is assumed in many of the assessments but often unreflectively. In the synthetic biology case study there is no clear trend concerning liberalisation in the reviewed assessments. It is still unclear to what extent synthetic biology should be developed in an open market fashion or should be subject to increased control of central authorities. Liberalisation often refers to the required open approach in developing synthetic biology. On the other hand, it is generally agreed that there should be strict boundaries concerning the extent of synthetic biology research. There seems to be a need to monitor technological developments and simultaneously assess the impact of synthetic biology based products regarding safety and security aspects. In the cloud computing case study liberalisation is assumed by all assessments. Indeed, there seems to be a close connection between cloud computing and liberalisation, each strengthening the other. In the case of nanotechnology the influence of liberalisation becomes most clear in the standardisation work of ISO. Although the standards that are developed here are voluntary, in reality they very often act as rules (Forsberg 2010, 30). Decreasing power of national governments and the global economic need for trustful labels, can explain the growing influence of such a supra-international (private) organisation. However, the participation in the committees that calibrate ISO standards are dominated by people from industry and research. Furthermore, the openness and transparency of the assessments on which the standards are grounded have shortcomings because ISO sees it necessary to create a protected space ‘where the experts may work in peace.’ (Forsberg 2010, 47). On the other hand, the Code of Conduct for Responsible Nanosciences and Nanotechnology that the European Commission recommended in 2008 has only had very limited influence on the

commercializing of nanotechnology based products.[3] These effects of shifting power and influence that can be seen as a result of liberalisation and globalisation are barely reflected in assessments on nanotechnology.

Within the domains, liberalisation is a reoccurring theme in the reviewed assessments. All the impact assessments selected discuss and assume that further liberalisation will be the case. In deliverable 1.1 we classify risk analyses to be a domain more directed towards generic or specific products, but even among the risk analyses one out of three assessments discusses liberalisation. In this line of thinking, it is surprising that the reviewed foresights are not addressing liberalisation. It is also striking that the economic assessments seem to discuss liberalisation but not include it as an important factor since a majority of the reviewed assessments discuss explicitly the issue of liberalisation but assume state control is at play while the rest do not explicitly discuss the trend, but assume it to be an important factor. Impact assessments all assume and discuss liberalisation, while the ethical assessments include liberalisation as a trend but not always in a reflective way.

Summary

Liberalisation and globalisation is a trend with great importance for governance and assessment of emerging science and technologies. The trend implies that assessments will be commissioned by other parties rather than national governments and this will have implications for the framing of questions for these assessments. Examples of such implications would be:

- A shift in focus from the overall public good to marketable products (private companies) and single public issues (NGOs);
- A shift in focus from wordy policy documents to practical advice;
- A shift in balance between opening up and closing down societal dialogue;
- A shift in definition of clients, stakeholders and shareholders;
- A shift in balance between democratic disclosure and competitive non-disclosure;
- A shift in focus from whether an innovation is socially acceptable (static) to how an innovation could become socially acceptable (dynamic).
- Liberalisation and economic globalisation implies that markets based assessment mechanisms will be of increasing importance for EST governance. Private consultancies providing such assessment services should to a larger extent be included in discussions about quality and transparency in private assessments.

Moreover, liberalisation may lead to ever increased reliance on economic assessments, at the potential cost of assessments that assume a larger extent of societal steering. Less regulation may

3 The Code of Conduct for Responsible Nanosciences and Nanotechnology was not adopted or endorsed by The Council of the European Union at the 2891st meeting of the Competitiveness Council, see http://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/intm/103101.pdf. [accessed 27/06/2013].

mean less risk assessment and less impact assessment. Finally, with a strong liberalist ideology funding for ethics assessments may be reduced.

3.2. New governance networks

'New governance networks' is an important trend to consider because, like liberalisation, it affects the possibility of societal steering of technology development. But while liberalisation leaves decisions to unidentifiable actors in the market, new governance networks involve new, but identifiable actors. 'New governance networks' is an important trend to consider because it affects who takes technology governance decisions.

This trend captures the on-going transformation of the role of the nation state which is reduced in its scope, making way for greater international and sub-national coordination and governance. Internationalisation includes subtrends such as increased international standardisation and the emergence of governance institutions which operate on an international scale. Supranationalisation refers to a situation where a scale larger than nation states gains prominence. Regionalisation refers to a situation where regional interests and powers gain prominence, detracting somewhat from the role of nation states. This trend implies so-called distributed governance, where networks of actors engage in governance processes rather than (or in addition to) nations developing policy.

Various European studies have considered the significance of new governance networks. The European Strategy and Policy Analysis System describes internationalisation as "the embedding of inter-state relations in a much more dense and complex transnational global political arena" (ESPAS, 2012, 139). In their report on global governance the EC highlights the "decreased salience of nation states and growing importance of non-governmental organizations and actors in all functions of governance, from setting goals and norms, selecting means, regulating their operations and verifying results." (EC 2009a, 5). The EEA (2011) considered in particular the environmental aspects of global trends on European activities. They identify a trend of *global regulation and governance*, which increasingly occurs in unconventional spaces, beyond traditional international treaty regimes. They characterise this trend by increases in

- regional cooperation/integration
- importance of groups such as G8/G20
- relevance of non-state actors, particularly public-private partnerships
- breadth of regulatory mechanisms applied, often including softer mechanisms in the form of guidelines and codes (EEA 2011, 91)

The Institute for Security Studies accepts that the global diffusion of power may present a 'responsibility gap', but also point out that no country can "guarantee prosperity and security alone" because of the degree of interdependence amongst member states and the international character of the major threats to environment, development and security (ESPAS, 2012, 127).

While new governance networks can be considered a global megatrend which affects science and technology policy, it can also be considered as a conscious transition which is enacted as a necessary

response to other challenges such as climate change and international security. The EEA describes such a scenario whereby current challenges demand "new approaches to enhance joint policy formulation in areas such as trade, environment, development aid, technology, and defence and security." (EEA, 2011, 97)

Implications of this trend

The diminishing role of the nation state can be regarded as both response and stimulus. These different interpretations are symptomatic of the fragmented state of knowledge of the trend's characteristics, mechanisms and implications (EEA 2011, 91). However, many of the European reports referred to above find that it represents an important transition, particularly for scientific and technical development. For example, the EC study suggests that the idea of global governance gives "moral ideals and ethical reflection more prominent roles in [science] governance than has customarily been the case" (EC, 2009a, 5) since we can expect global discussions on both the means, norms and ends of policy amongst a growing number of actors as business, NGOs, governments and other interested or affected parties.

Furthermore, the diminishing role of the nation state can be considered in terms of problem spaces such as economics and governance as well as specific challenges such as climate change. Economic internationalisation is discussed in the section of liberalisation. Political or governance internationalisation means that, as the scope of economic and intellectual efforts in science and technology expand, so too may the governance of science. In this domain, the growing complexities of trans-state relationships are exposed (EC 2009a, 9—10). Emerging technologies are often positioned as the stimulus for or response to specific challenges which are global in scope, such as climate change. The beneficial and/or harmful aspects of emerging technologies must be considered on a global scale, and may introduce conflicts with economic or geopolitical interests.

Building capacities at regional, national and international scales is recognised as important because of the "rapid development and possible deployment of new technologies that may also have unintended negative impacts, in particular on biodiversity and health, or other unforeseen consequences" (UN 2012, 55). Rapid technological change appears to constitute an important trend in itself and is also considered in this report.

It seems that, minimally, this trend implies that more groups other than national governments are and will be involved in the commissioning, production and use of assessments. This, in turn, implies that there may be shifts in the framing of assessments which could have significant procedural and consequential effects. Moreover, the trend may lead to more actors adopting a broader range of roles as regards the assessment of technologies, leading to a more diversified set of clients and stakeholders. This will again imply that a more diverse range of interests will be at play, which could lead to a less unified portrait of technologies than would be the case with a smaller range of actors. An implication may be that assessments fill a broader range of assessment roles, in the sense outlined in the TAMI project (Decker & Ladikas 2004). However, making decisions in such a distributed situation may prove to be harder.

Of course, beneficial changes may also be expected in the body of assessments under this trend. For example, assessments may be more internationally relevant than would be common in national assessments. The ETC group have called for a mandatory international assessment convention for new technologies under the auspices of the UN in order to "ensure the conservation of useful, conventional or culturally distinct technologies and promote technological diversification and decentralization" (ETC group 2010, 43). Moreover, where non-state actors commission and deliver assessments, the language and structure may be freed from the burdens of legal and regulatory language and deliver more accessible reports, which may provide more practical advice.

Examples from the case studies capture this movement well, such as the Action Aid report considered in the biofuels case study, which considered international perspectives in an approach that would not be expected in research framed by national interests. In this report the impact of biofuels was studied from the perspectives of poorer countries and not according to EU needs or economic parameters (Action Aid 2010).

A case study that illustrates the importance of internationalisation is cloud computing.[4] Given the globally distributed nature of cloud computing, this technology may well be positioned as part of the tide of internationalisation. It is a potential enabler for more geographically distributed activities, both commercial and personal. The international structure of the technology implies a need for international standards and regulatory frameworks and, as such, we might have expected cloud computing assessments to assume the contextual role of an internationalisation trend. Indeed, this was the case with all 18 assessments, 14 of which doing so explicitly or reflexively.

In the case of biofuels, internationalisation was assumed by 8 of the 20 assessments, usually in an unreflexive way, by highlighting the international mechanisms of technology governance over those of nation states, or voicing concern for the international impacts of biofuel development. This is interesting as biofuels policy is inherently related to international matters, affecting global resources and energy supply.

The case study on synthetic biology shows the majority of assessments emphasising the need for international governance (7 out of 11). This may be because the technology draws from various specialist knowledge fields which are likely to be distributed across nation states borders. State control is, however, also often cited as crucial in order to facilitate the optimal development of national specialisms. European and international fora might be able to facilitate an optimal balance between state control and coordinated transnational approaches (see also section on policy integration).

4 In the protocol for reviewing assessments we focused on the internationalisation aspect of new governance networks, as this was initially deemed to be the most important aspect of the new governance networks. Later in the project the scope of this trend was widened.

Internationalisation is the trend most often assumed by the assessments. Aside from the assumptions within the assessments we considered, a trend of new governance networks is also visible in the groups involved in commissioning and producing assessments. In addition to state actors such as government departments, there are also many international entities such as the UN as well as specialist NGOs and advisory groups which operate globally. The assessments produced by actors in this 'internationalist wave' can be considered aside from the national assessments, to consider whether and how they differ. It is found that this depends upon the case study. For example, in the biofuel case study, the international assessments were generally less impartial and transparent, included less stakeholder participation, had a lesser scientific evidence basis and did not consider as much uncertainty or make their value positions as explicit. The only measure the international assessments scored higher for was the participation of lay people (expert participation was equal). The synthetic biology case study was similar, with the national assessments scoring *significantly* higher in all aspects except the scientific evidence basis, which was marginally lower than the international assessments.

However, the other case studies present counter evidence. In the nano-food case study, international assessments began to enter the assessment ecosystem somewhat later than others, coupled with an influx of risk assessment studies and guidelines. In contrast to the biofuels case study, however, no significant difference was noted between the international and national assessments, except for making ethics and values explicit, at which international assessments performed significantly better. The national and international case studies presented in the cloud computing case study further muddied the picture with international studies scoring higher for impartiality, scientific evidence basis, treatment of uncertainty and the participation of both experts and lay people, while the national assessments scored higher for transparency, participation of stakeholders and explicit value positions.

Relating to the different domains, we find that most of the reviewed technology assessments reflectively discussed a diversity of governance levels. In addition, all EU impact assessments discuss this reflectively as part of analysing the different policy options considered in order to meet a given objective. In the other domains (except risk analysis) there is a clear tendency to address several governance levels, but a systematic discussion due to the applied methods cannot be inferred.

These findings suggest that studies which emerge as part of this trend of internationalisation have, in the cases of biofuels and synthetic biology, a lesser overall scientific quality and level of participation than more traditional national studies. This could have serious implications, particularly where governments promote internationalisation as means of responding to important contemporary problems. The counter evidence presented from the cases of nano-food and new ICT show that further work would be required to understand the validity of the claim and the mechanisms that drive it. For example, it may be that participative, international studies in certain domains face greater economic and practical challenges than a national studies, or international studies from other domains, because the participants must reflect more diverse group of lay, expert or stakeholder actors.

Summary

- New governance networks may be required for addressing new societal challenges, such as climate change. This also implies a need for assessments at, most importantly, a global level.
- Differences in quality are found between national and international assessments, but these vary from case to case. Potentially an important topic, these findings should be further investigated in future research.
- All reviewed TAs and impact assessments assume diversified governance levels. The other domains tend to make such assumptions, but not systematically.
- In biofuels only a minority of the assessments included internationalisation. In the other cases this trend was present

3.3. Public-Private Partnerships

Public-Private Partnerships (PPPs) are forms of long-term cooperation between public bodies and private companies with the purpose of establishing and maintaining infrastructure or to run public services. “Partnerships” between states and private businesses (e.g. monopoly concessions) have always played a role in modern political economy. Today, however, the term generally refers to partnerships created as part of a trend towards liberalisation of public services since the early 1990s. The use of PPPs began in Thatcher’s years as UK Prime Minister, and the UK is still by far the most active user of PPPs as a policy instrument (EPEC 2012). The use of PPPs, however, has spread to various degrees to other EU member states.

PPPs differ from traditional contracting in terms of: duration (PPPs often last longer); methods of funding (often involving a mix of public and private funding); the depth of involvement of the private partner(s) (taking on a more proactive role in defining, completing and implementing the project); and the sharing of risk between public and private partners (EC 2004).

The European Commission adopted PPPs as a recommended instrument for financing public services with its Green Paper on Public Private Partnerships in 2004. Since then, the use of the instrument in member states and at European level has been a generally growing trend. From a relatively low economic volume, a sharp increase of 23.6 billion was seen already in 2004—06 and peaked in 2007 with around 28 billion EUR worth of PPPs established in that year alone (Hall 2008). After the onset of the financial crisis, the EC has proposed accelerating the use of PPPs as a way of boosting the economy (EC 2009b). But while privatisation of public services in the ordinary sense has been driven forward by the ECs crisis policy (Zacune 2013), partnerships constructions have seen a significant decrease following the general economic downturn. In 2012, PPP volumes reached the lowest point since 2003 with 11.7 billion EUR worth of partnerships established that year (EPEC 2012). This tendency is in stark contrast with EC projections that 1.5 – 2 trillion EUR worth of partnerships will be needed to meet European infrastructure needs from now until 2020 (EPEC 2012)

In research and innovation, PPP's became part of European research policy with the 7th Framework Programme in which the Joint Technology Initiatives (JTI) instrument was created. The purpose of these initiatives is to support trans-national cooperation in fields of key importance for industrial research (EC 2007). Among criteria for the identification of candidate research areas for JTIs are both the scale and impact of such an initiative on industrial competitiveness and growth and the importance of the contribution of the initiative to broader policy objectives including benefit to society (EC2012a). To ensure initiatives strike this balance, proposals by the Commission for new JTIs are accompanied by impact assessments as well as analysis of economic and social effects (ibid.). Individual JTIs have been set up in the areas of innovative medicine (IMI), aeronautics and air transport (Clean Sky), embedded computing systems (ARTEMIS), Nanoelectronics (ENIAC), and fuel cells and hydrogen (FCH). The economic crisis, while leading to a general decline in PPP's (see above) and also to an initial dip in research and innovation funding is now accelerating the turn in public research and innovation policy – visible already before the crisis – towards strategically targeted funding instruments (OECD 2012) – among these PPPs.

Implications of the trend

The increased popularity of public-private partnerships as a means for delivering public services can be linked directly to the limitations on members states' fiscal policies imposed by the Maastricht Treaty. The Treaty puts a lid on state spending and forces states to find sources of non-public financing for services that require higher spending than the lid allows for. The strictness of these limitations have become even tighter during the economic crisis as after which initiatives such as the Fiscal Compact of January 2013 have strengthened the mandate of the European Commission and Council for oversight and intervention in members states' fiscal policy. This situation is a basic premise for all member states' fiscal policy. Assessments of any domain must take into account this premise in any context where advice is given on state-driven technology development. Assessment producers aiming to make recommendations on the steering of research and innovation may find themselves under pressure to produce scenarios that include PPPs as solutions to delivery of technological components of infrastructure or public services or PPPs to harness science for economic growth, even to the degree where advice to the contrary might be ignored as irrelevant or politically 'tone deaf'.

The policy trend of a growing importance of PPPs might lead assessment producers to choose assessment methods able to produce ideas for PPPs or to highlight the potentials in the construction of PPPs in a given area. This might in turn favour assessments carried out from a constructive-innovative perspective, where the broader societal lines of development might be left out, and where broad tendencies in emerging science and technology would be assumed rather than critically appraised.

The importance of PPPs for current policy might mean that processes of sectorial stakeholder involvement and co-constructive approaches would become predominant in parts of the policy value-chain having to do with securing the delivery of public goods and harnessing research for growth and societal benefit. In this context, the trend could produce a bias towards positive

outcomes of such processes rather than outcomes leading to public-private development projects being dropped. As many of the ideas underlying the tendency to choose public-private partnerships over purely public sector projects are contested, values may remain implicit such as assumptions of the overall desirability of PPPs compared to traditional public projects and more open research funding structures. It is especially important to beware of the public sector enthusiasm for public-private partnerships, which for some fly in the face of evidence against the effectiveness of PPPs. We noticed for instance in the case study on synthetic biology that the one assessment body reflecting on PPPs in its assessment was the OECD. And while PPPs may be made to look like attractive solutions on paper, in our case studies across assessment domains, they rarely seem to crop up as the best or even interesting solutions to core issues of research and innovation in assessments made by independent assessment bodies.

In critical appraisals of assessments, one would therefore have to scrutinise especially tendencies to ignore or underplay the real cost of PPPs and to overestimate the likelihood of ultimate success for such projects. In particular, one should beware of assessments' assumptions about consumer/citizen acceptance of the outcomes of PPPs as both public and private sector assessments would have incentives to skew these expectations in a positive direction to favour the PPPs to be carried out.

The PPP trend puts an increased focus on areas of S&T development where public and private interests overlap, and it nourishes the growth of private sub-sectors with a symbiotic relationship to the public sector. In this overlapping area of technology development, governments might become less vigilant in their oversight of private actors as the bond formed around mutual interests between public bodies and private actors becomes harder to break. Likewise, governments might become less critical of S&T trends that promise to solve problems in the governments' own delivery of public goods. Such promises can easily be tacked on to development projects already in the making. We see this for instance in our cloud computing case study where some promote cloud computing as a futuristic panacea for sustainability. If public bodies dealing with research funding do not work systematically to dismantle such artificial claims, technology governance would take on a "pull" function matching the 'push' of these specific sub-sectors and loose some of the critical edge inherent to the public sector's role as guardian of the public as such against haphazard technological development. This affirms the importance of politically independent assessments of emerging science and technology, especially in areas with great economic potential, being carried out with contributions from economic, risk, foresight, TA and ethical perspectives.

Few assessments in the domains and cases studied address PPP as a trend in technology assessment and governance. It is not often clear if the limited focus on public/private partnerships is due to being unrealistic considering short-term vs. long-term synthetic biology developments, or if PPPs are not viewed as viable. At least, one may conclude that most assessments do not include such 'downstream' issues. In EST-Frame this last assumption is of high importance because the implementation and actualisation of technology policy cannot be seen as separate from the technology itself. An important implication for integration is that the manifestation of technologies in practical policy initiatives needs to be addressed at some stage in assessments of new and emerging technologies.

Summary

- PPPs are rarely addressed in assessments, even if they are put forward as important policy measures in official policy, especially in the EC.
- The manifestation of technologies in practical policy initiatives, such as PPPs, need to be addressed at some stage in assessments of new and emerging technologies.
- PPPs strengthen economic concerns in STI policy. It is important that these are balanced with also non-economic assessments.

3.4 Citizen empowerment and public deliberation

Citizen empowerment is a trend that is already affecting technology development and governance, and is at the same time a result of technology development and governance. Citizen empowerment involves respecting social diversity, a phenomenon of increasing importance in societies where traditional value systems are in motion.

Whereas technology can be a used to control people or can result in something that outstrips human beings, it can also be main drivers for the empowerment of individuals and the access to a global community that can contribute to greater social equality. In many affluent countries this ideal of citizen empowerment, - individuals that can endeavour a stronger social and economic position through "better access to education, information, and economic and political opportunities" (ESPAS 2011, 12) — is closely related to the ideal of democratisation that stresses the opportunities of citizens to participate in societal and political debates on issues and developments that can be expected to have great influence on their everyday lives. Democratisation also entails respecting the social diversity that characterises populations of many modern societies. In our case, such diversity is related to the pluralism of values that can be seen in debates on technology innovations.

Populations of modern societies are featured by individualisation and many different life styles (heterogeneity). Besides this it has become common knowledge in social studies on public and consumer concerns that these are always embedded in a social context that cultivates and influences these concerns (heteronomy). The autonomy of modern citizens/consumers is only relative, should not be seen as an entity in a value-free vacuum, but is always influenced by several outside forces.

There are several interconnected constituents of these two general characteristics:

- Individualisation: people have become less dependent of family and traditional structures, social relationships have become more egalitarian and personal choices and have become more central in people's biographies.
- Intensification: the experience component is an important part of modern life, desires, feelings and emotions are more recognized as legitimate forms of (individual) expression.
- Informalisation: the power and authority of institutions has become less tacit, is less easily accepted people (de-institutionalisation); social contacts have become much more informal and institutions have to work harder to earn public trust and loyalty.

- Information: the rise of ICT (computerisation) has led to an enormous availability of knowledge and different information; internet offers all kind of citizens' organisations new means to express their interests and public concerns.
- Involvement: although not all citizens and consumers are directly interested in technology issues, there is a general expectation that public interest groups should be involved in these developments and that the public must be given the opportunity to participate in debates on important issues and concerns.

The most significant implication of citizen empowerment historically has been increased importance of so-called deliberative democracy or participatory approaches to technology assessment. The deliberative model of democracy should not be thought of as proposing an alternative to the prevailing parliamentary bodies of representative democracies. It is rather to supplement or strengthen these bodies with procedures for a more direct involvement of people in the formation of policies. This opinion-formation in public deliberations should offer fertile soil to feed subsequent decision-making processes in formalised democratic institutions. The kernel of the deliberative model of democracy is that public deliberation should be enhanced in order to enable people to (re)gain influence in the processes of political opinion-formation. Its core procedural device is that substantial political decisions should be the outcome of extensive public deliberation between free and equal citizen. The deliberative model of democracy claims that political decisions could only claim democratic legitimacy if they are preceded and followed by extensive public deliberations. Governmental policies should always be subject to public scrutiny.

At the heart of the deliberative model of democracy is an emphasis on genuine participation of citizens in the public process of deliberation: "a process in which citizens attempt to convince others to adopt certain policies on the basis of public reasons as they emerge in the give and take of deliberative dialogue" (Bohman 1996, 15).

Deliberative democracy is a means to handle politically controversial issues through dialogue rather than through violence or pre-established power-positions, a means of living together in a relation of mutual tolerance for the plurality of, possibly conflicting yet reasonable, visions of the good life in contemporary affluent societies. This plurality has an important cause in the process of individualisation that features modern societies that has led to great(er) social diversity. This social diversity might lead to conflicting visions that can cause trouble, but can also be seen as a something positive; a process of a 'creative exchange of arguments' leading to mutual understanding and trust. According to Boden et al. (2010) the EU should embrace the multicultural and social diversity of its citizens and approach this as a competitive advantage. Democratic participation is vital in this context: "Channels to facilitate communication and dialogue with all citizens can be created by adopting a strategic agenda for developing democratic participation." (Boden et al. 2010, 32)

Extensive public deliberation may also improve political decision-making, because it invites people to (re)consider their initial opinions in view of other people's opinions and interests. A deliberative democracy encourages people: "not merely to express their political opinions (through opinion polls,

referenda and the like), but to form those opinions through debate in public settings" (Miller 1993, 89).

Participatory assessment of technology

The setup of technology assessment offices has been important for empowering citizens to influence STI policy. During the 20th century, the explosive expansion of science and technology meant that democratic politics became ever more technical and specialised. The faculty of common sense belonging to educated citizens was no longer enough to guide politicians in their choices. Deeply specialised advisory units came to play an increasingly important role in the formation of political views and attitudes, and technocracy encroached on the authority of democratic institutions.

During the height of the cold war, this development was seen to skew the balance between governments and parliaments as parliaments suffered from a "knowledge deficit" compared to governments' apparatuses of scientific advisors. Developments were therefore set in motion to strengthen the parliamentary side of the political process; among these the establishment of alternative centres of expertise on science of technology such as technology assessment institutions and ethical boards. Initially, these institutions (the prime example being the U.S. Congress' Office of Technology Assessment) took on the role of strategic scientific advisors for parliamentarians. But in Northern Europe (Denmark, the Netherlands and Norway especially), parliamentary technology assessment came to take on a different form in which citizens became involved in political processes in various ways. The basic idea was to counter specialization and the general tendency towards technocracy through confrontations with the common sense of ordinary citizens and the lifeworld, they represent.

Therefore, in the last decennia an increased awareness of the need to involve lay persons and "the public" in processes of STI-related decision-making, reaching beyond the already well-established processes of stakeholder involvement, has emerged. Against the background of many techno-scientific controversies and the lack of public acceptance for many new technologies, the so-called "deficit model" promoted by the Public Understanding of Science Movement proved to be flawed. Research into public resistance to or scepticism regarding new technologies indicates that providing the public with more expert information regarding the advantages and risks inherent in new technologies, as well as ways to minimise those risks, rarely results in greater acceptance, and that it may even be counterproductive. It can even result in greater scepticism about new technologies (Scholderer & Frewer 2003).

On the basis of this experience, more and more attention is being given to methods for dialogue with the public (Frewer et al. 2004). Experimental methods such as citizen hearings and consensus summits became well established and gradually spread throughout the political systems of Europe under the heading of "citizen participation". In the 1990's, the European Parliament took up these methods and employed them in various ways. Also the European Commission began to accept citizen participation as a viable method for giving greater democratic legitimacy to its governance processes. In recent years, participatory methods have furthermore been employed at trans-European and international levels (e.g. the CIVISTI and World Wide Views projects).

However, public engagement is not easy to achieve and some scholars doubt whether this kind of dialogue offers enough room for criticism of existing technological developments. According to Stirling (2008), there are a number of preconditions which must be met in order to avoid a situation in which social participation is used to stifle discussions prematurely. Irwin (2007) poses that despite all the appeals and protocols by political leaders, engagement almost always fails in practice; in his view more dialogue, like more information, can (also) act as a catalyst for critical attitudes. Debate has also arisen both concerning the compatibility of participatory democratic processes with traditional representative democracy (Sarugger 2010) and the plausibility of participatory processes as a legitimising factor for European governance (Bellamy & Castiglione 2011).

Implication of this trend

In the case and domain studies the scores on participation of lay people are generally low. There is a general cross domain and case tendency to include stakeholders to a larger extent than lay people. Risk assessments rarely include stakeholders, while the other domains tend to include stakeholders, but not systematically. However, one should note that in the case of nano-food there have been some intensive efforts to involve lay people. The societal dialogue in the Netherlands on nanotechnology in 2009—2011, with a budget of 4,5 Million euros, is a good example of such efforts. The experiences in the past with biotechnology might explain why the involvement of lay people has received such relatively high degree of attention in assessments concerning nano-food. Still, also in cases that lay people had good opportunities to participate, the question remains whether this can count as a success of citizen empowerment and democratisation (see Krabbenborg 2012 for the Dutch Societal Dialogue on Nanotechnology). Opening up technology assessment events for lay people does not in itself ensure that empowering techniques are used and that democratisation is achieved.

The implications of citizen empowerment are well-known and established in many practises of technology assessment (TA). In more expert based assessments (risk assessment, economic assessment and, to some extent, ethics assessment) there are still many traces of a public understanding of science (PUS) approach, where the public deficit model is alive. The public and stakeholders are not here seen as partners in the assessment, but as recipients, often representing a perceived communication problem to the assessors. In the EU impact assessments lay people are systematically included, facilitated by the “Your Voice in Europe” (http://ec.europa.eu/yourvoice/) which is a platform for public consultation.

In the nano case we found that there have been a number of public participation events, but that there seems to be fewer of these over time. Perhaps one reason is that what is mostly called for now is risk assessment, which is more expert-based.

In synthetic biology there has not been much public engagement yet, even if informing policy makers and stimulation of the public debate are often mentioned drivers for assessing synthetic biology. Since most of synthetic biology’s development is still based on fundamental research, the majority of the assessments draw on expert information. Moreover, there is a low level of public awareness of this kind of research and so far there has been a need to map the issues before more inclusive

deliberative events are organised. Due to the uncertainty associated with synthetic biology and the lack of empirical evidence concerning the potential impacts of synthetic biology, there has been considerable shaping of attitudes concerning issues including biosafety and security.

There has also not been much involvement of stakeholders in synthetic biology. Several authors have already stressed the importance of co-development, between future technology up-takers (industry) and consumers of products dependent on such technology, in the early phases of technology development. There is relatively little attention related to the foundation of structures which enable communication between the private and public sphere in general. Multi-stakeholder technology platforms might prove to be useful constructs to realise such improved communication.

Moreover, in the case study on synthetic biology, consumer acceptance is often reflectively discussed within the reviewed reports. However, there seems to be no consensus how and to what extent synthetic biology products would be accepted by consumers. Acceptance might be influenced by (a) the type of product, and (b) the way it is being produced (production organism).

In biofuels the scientific state of the art is already well-known and the issue is also well-known in the public. However, here there have been few participatory events. In the cloud computing study we also find that though the technology is well-known it has not been deemed necessary to engage the public in deliberations on cloud computing governance; the public have only been involved through being consumers.

No matter the meaning for democracy – positive or negative – of the changes happening in European governance, the positive valuation on the side of the Commission of methods for involvement of stakeholders and civil society must be expected to benefit advisory domains that contain such methods, e.g. technology assessment and ethical analysis. The nature of this expected opportunity for growing influence for these domains is however not at all clear at this point in our research.

A related question is whether the use of participatory methods encroaches on the territory of well-established advisory domains such as economic analysis, or are we rather experiences an overall growth in the "business of advice"? Will we, in other words, see an increasing substitution of traditional expert analysis by more open processes of idea forming, or will still more expert advice be produced along with new kinds of advice from stakeholders and civil society? This last question is important to answer before we can answer the question of the *relative* importance of the different advisory domains. If economic advice along with other kinds of "hard" scientific advice is still viewed as more true, or at least policy relevant, than the results of open processes, use of participatory methods may grow but only as a way to legitimise centrally taken decisions and not in a way that increases their relative importance.

If participatory methods on the other hand are placed still closer to the centre of decision-making and given ever more weight, a new kind of democratic deliberation may indeed be taking form on the commission side of European governance. In EST-Frame we do not have hard evidence supporting claims about such a development, but from the deliverable 1.1 domain studies there is at least no evidence of a reduction of importance of any of the domains, while there is a growth in the

number of participatory assessments/events over the last 20 years. This does not necessarily mean that participatory events only have a legitimising function. For instance participatory events are mostly organised in advisory environments (parliamentary TA offices) that cater to parliamentarians, whose jobs are exactly to deal with public values, while expert based assessments mainly cater to civil servants. In this way the different kinds of assessment forms simply have different functions. Still, we believe that regular assessment bodies should set up a general communication platform with the public to be used in all the phases of an assessment. Strengthening of stakeholder inclusion on all issues and in all domains is needed.

The implications of social diversity are hard to trace in the case studies. One may point out that in spite of a general social diversity in society there is surprisingly low extent of diversity in the views on cloud computing, or emerging ICTs generally. In other issues that have clearer ethical dimensions, such as synthetic biology, we might expect a larger extent of conflict to result from social diversity once technology applications are starting to appear in the public. However, how such a dynamic will unfold is likely to be determined by many factors, such as the nature of the applications, the occurrence of specific threats (e.g. dual use situations) and the perceived adequacy of governance measures introduced. Such events may therefore instead be designed to map values, instead of closing down on specific technology alternatives (what Stirling 2008 calls an opening up rather than closing down).

The implications of social diversity are perhaps more significantly expressed in the domain studies as a methodological challenge. In expert based assessments where assumptions are made about the preferences or values of the public, such assumptions must necessarily be harder to make when the value heterogeneity in society is increased. In such a situation concepts of autonomy and choice become more important, with corollaries for the significance of information of risks and of transparent labelling practices.

Social diversity and different conceptions of the good may be addressed through inclusion of narratives, worldviews or visions in the assessments. There is no domain that assures systematic inclusion of these (see also deliverable 1.1).

Summary

- Citizen empowerment and democratisation continues to be an important trend in European governance.
- Empowerment of citizens and parliamentarians alike is important for technology assessment.
- Problems related to methodology and real impact of deliberative approaches remains. Increasingly social diversity makes consensus harder, and may be an incentive for information and labelling measures rather than consensus events.
- Most advisory domains/institutions do not have systematic instruments for including lay people in empowering ways.

- There is no systematic inclusion of lay people in the domains except impact assessment. Risk assessments and economic assessments never include lay people while this might occur – even if it seldom does so – in the other domains.
- In order to avoid the inclusion of a broader audience into assessment as simply a PR tactic, transparency in such mechanisms is important. Standards for transparency should be worked out in order to quality control of the deliberative processes.

3.5. Rapid technological change

Rapid technological change may be seen as the essence of emerging science and technologies, and is thus a trend that is of fundamental importance in EST-Frame.

The issue of Rapid Technological Change concerns speed, a multitude of technologies and perceptions of change, and the intersection between these. In addition to the two dimensions of the Collingridge dilemma, the lack of information at early stages and the lack of power at later stages of technology development (Collingridge 1980), we are also concerned with a seemingly accelerating change both in technologies, technological applications and innovation generally (ICSU 2011, 10).The ICSU foresight states that this trend will be one of the few that one can take for granted:

> *The impact of technological change on society is more difficult to predict than some of the other megatrends. However, the exponential increase in the rate of technological change is a pattern that is likely to continue for the next 20 years. Forecasting specific technological developments over two decades is very uncertain but the speed of innovation and change is more predictable. (ICSU 2011, 10)*

In the reports investigated for describing the trends, the European Environmental Agency warns that the speed itself will create a race to innovate that puts huge burdens on risk regulators:

> *The dynamics of global innovation create an accelerating race into the unknown. This race offers tremendous opportunities for solving pressing environmental problems. But it also increases external dependencies and risks, particularly given the under-investment in water, energy and transport, which underpin most of our economic and technological activities. Risk regulators will increasingly operate under conditions of great, and often irreducible, uncertainty. (EEA 2011, 41)*

Such sustainability and safety issues suggest addressing technological change in light of the *precautionary principle* (Unesco 2005). The precautionary principle is already part of EU legislation and included in product authorisation procedures (Schomberg 2011).

The issue of rapid technological change is sometimes seen as an obstacle to a sound innovation policy because of the difficulties involved in creating technological standards. Such standards are also necessary seen in a health and safety perspective or regarding different aspects of sustainability.

> *The rapid development of technologies is sometimes not compatible with the time necessary to build a consensus via the use of formal standardisation routes. This situation creates incentives for industry to use informal standardisation channels for the rapid development of technical specifications with an international reach. (EC 2010, 57)*

Such informal standardisation is also related to discussions of co-regulation. In its report on cloud computing the World Economic Forum (2011, 17) proposes that "as a long-term goal, governments may wish to explore a "macro-regulatory framework" that will be more adept at keeping pace with rapid technological change. Options include a "co-regulation" approach, whereby industry takes the lead in identifying necessary provisions and governments take a policy and oversight role."

Here the industry would develop standards and solutions while the governments agree to a basic framework wherein this development could take place. UNESCO (Rundle & Conley 2007, 35–37) is cautious to this approach because of issues of market dominance and privacy on the one side, and on the other the fact that many governments (can) use digital technologies to violate its citizens' basic rights. Moreover, it is doubtful whether governments will leave its security concerns in the hands of a cooperative industry effort. One intention behind the World Economic Forum's initiative is to open up a common space where the stakeholders must take responsibility for the innovations and inventions and, consequently, integrate such ethical, social, and legal concerns into the product development, the so-called "ethics by design" or "responsibility by design" which can be obtained through design of products or setting up institutions (Schomberg 2011; Ho & Ng 2012).

Implications of this trend

The currently important concept of responsible research and innovation (RRI) is also part of this soft governance response to rapid technological change (see below). However, rapid technological change may amount to a value challenge to society. Radically novel technologies may present society with ethical choices and dilemmas of a novel kind. This might imply a need to act (establish hard and soft law and making policies) before the value issues are properly clarified and a societal debate on relevant values has had time to mature. In such a situation transparency on value assumptions in assessments and policy is crucial.

The report from World Economic Forum quoted above is a foresight. Assessment domains that include anticipatory resources will be crucial for tackling rapid technological change, especially foresights, technology assessments and impact assessments.

In a society with rapid technological changes there will also be debates on the urgency to regulate the perceived changes (Kitcher 2011, section 28). Such debates calls for some kind of anticipatory knowledge and qualified suggestions on the direction of technological changes and mechanisms in order to establish plausible scenarios. Different understandings of such scenarios can open up for different understandings of rapid technological change.

Rapid Technological Change is a trend that presupposes a view in the assessments that the technological pathways are hard to foresee and that the changing societal contexts will provide different meanings and unforeseen applications of both new and old technologies. We assumed in this study that an acknowledgement of the importance of rapid technological change would necessarily include high focus on uncertainties and ethics. The different forms of TA and foresight have methods for systematising reflections, discussions and views on such changes – even though they are more directed towards the technological than the societal changes for technologies. TA and

foresight include methods for systematic investigations of uncertainties on different levels – from production chains via consumer preferences to societal, economic, and environmental impacts.

Approximately one half of the reviewed assessments in TA can be said to address implications of rapid technological change through inclusion of both values and uncertainties. The same extent is found in the reviewed ethical assessments. In the reviews, TA included uncertainty systematically and ethical assessments included values, but the combination was not systematically present. In the analysed foresights, however, the focus on uncertainties and ethics is not as high as one might expect. There are also differences within the toolbox of the foresight domain. Foresight methods that focus on technologies may generate more uncertainties because they start with the current technology status and will therefore need to address technological changes along their assessment time horizon. Assessments that start with exploring solutions to societal changes (such as future oriented technology analysis, FTA) will perhaps to a larger extent assume that the speed and direction of technological changes is in society's control, and not only something we need to relate to and address.

Looking at the total of reviewed cases and domain studies, it seems that assessments that address uncertainties in a systematic manner and uses uncertainties to inform the conclusion in the assessment also considers different ethical values, and those assessments that regard ethical values also include uncertainties. The opposite, i.e. where ethical values or uncertainties are not systematically addressed, the other trend also seems to be absent.

Rapid technological change represents a methodological problem. Only one of the reviewed economic assessments focused to a high extent on uncertainties and values. As most EST are in rapid technological change this amounts to a problem in using this domain as a policy basis.

When it comes to the cases, there was a working hypothesis that the less developed the technology was, the larger focus there would be on rapid technological change. This hypothesis does not seem to have been directly contradicted. In the case of synthetic biology we see that several of the reports investigate both values involved and future uncertainties. And in the case of biofuels such considerations were almost absent. In the nano-food and cloud computing cases there were no systematic findings.

Summary

- Rapid technological change is important as it poses difficult governance problems. Risk assessment and corresponding regulatory processes are slower than the speed of technological change and can often not keep up. Applying the precautionary principle must therefore be considered.
- Informal governance measures, such as codes of conducts and ethics by design principles, have been proposed as more flexible means. However, these must take into account that rapid technological change may affect basic societal values.

- Rapid technological change also poses serious methodological challenges for economic projections, which must be taken into account in the governance of emerging science and technologies.
- The assessed domains are similar in their lack of treating rapid technological change in a coherent way.

3.6. Focus on Sustainability and Climate Change

Sustainability has been identified as one of the global megatrends in policymaking for the coming 10 to 50 years by several think tanks, foresight institutes and decision makers. So for the assessment context for the emerging sciences and technologies, how – or to what extent – is sustainability perceived and integrated?

Sustainable development is defined as meeting "the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987, 43). A specification of sustainable development includes: "Economic development, social development and environmental protection are interdependent and mutually reinforcing components of sustainable development." (UN 1997, 23). It is this last understanding of sustainable development as being composed by economic, social and ecological factors that constitutes the EU understanding of the term (Schomberg 2011, 9). However, this interconnection of different factors necessitates that complex societal and ecological factors become operationalised.

In the reports probing future trends, there is an agreement that the current way of growth through over-exploitation of natural resources is not ecologically sustainable (EEA 2011, 21; ESPAS 2012, 16; EU DG Research and Innovation 2012, 11). This kind of ecological unsustainability is connected to economic and social unsustainability through a number of parameters. The EEA suggests:

Directly, economic growth increases the burden on the natural systems that sustain us. Indirectly, global economic development affects Europe's position and competitiveness, with economic, social and environmental consequences. […] Achieving this will depend on the success of coordinated environmental (climate, biodiversity, pollution) policy measures creating a level playing field for European economic sectors. (EEA 2011, 50)

A topic of growing importance within the environmental pillar of sustainability is climate change. This has lead to increased attention to the environmental dimension (and also the economic dimension), but its social implications are (as in sustainability assessment in general) harder to assess. Since both climate change and resource scarcity are global phenomena, all countries need to seek greener technological innovations in order to maintain the standard of living. Furthermore, the 2008 financial crisis also contributed to increased social and ecosystem degradation (EEA 2011, 104), and ESPAS also suggests that this financial crises in itself might have been the result of a decoupling of the financial sector from the social and ecological perspectives (ESPAS 2012, 61).

The key issues are uses of non-renewable (or non-cleansable) resources and global distribution of goods and labour rather than Malthusian perspectives on overpopulation and a fixed (zero-sum) preconception of resources. In such a setting, the thinking around development and governance of new and emerging technologies can be informed by reflections on sustainability. Technological innovations are perceived to be necessary both for social and economic sustainability. The UN High-level Panel on Global Sustainability states:

The overall impact of technological and other innovations in the sustainable development agenda will be guided not only by the effect they have on humanity's ecological footprint, but also by the extent to which poor countries and vulnerable groups benefit from new technologies, and by how well possible risks that new technologies may introduce, both for people and for the environment, are managed. (GSP 2012, 23)

According to the GSP, since most of the current methods of governing resources are seen as low-tech and wasteful, new high-tech and sustainable methods must be introduced in order to save the climate – and the people – from too large damages. GSP places such changes under the heading of "Green growth" which consists of making new innovations that are tailor-made for local circumstances (GSP 2012, 24–25) ESPAS acknowledges that there is an inherent tension in this logic where both aspirations to growth and limits to growth are to be achieved simultaneously. With developing countries driving and reshaping the economic and political realities at both an international and global level, how can we ensure that such countries are given their fair place without jeopardising the existing and the future gains in securing the commons and combating climate change and pollution? According to ESPAS sustainability cannot be seen as a purely ecological issue precisely because of the issues mentioned above:

Traditionally framed as an environmental issue, sustainability actually encompasses different policy fields including finance (investment), trade (subsidies and restrictions), broad economic policies (commodity inflation, costs of green growth), state and human security, and migrations. (ESPAS 2012, 142)

Implications of this trend

Integrated sustainability assessments have become an increasingly important area of research within environmental management. Recognising sustainability as an important goal of environmental management reinforces the importance of non-reduction. A wide range of researchers working on environmental management have contributed with important work on developing non-reductive integrated assessments over the last few decades (see for instance Ridder et al. 2007, van der Sluijs 2002, van Asselt et al. 2001). Some of these approaches are based on computational simulation models (e.g. Epstein 1999; Hare & Deadman 2004), while others have been more deliberative (Soncini-Sessa et al. 2007 and Cohen and Neale (eds.) 2006).

Because of the three pillars of sustainability deliberative sustainability assessments would need an inclusive design. It does not seem sufficient to include only scientists, laypeople or stakeholders from one sector of society. Since sustainability should be understood as a substantive value which poses

restrictions on the range of possible actions, there need not be an impartial process – in the meaning that all options are open – altogether, but an agreement that sustainability is the background or the goal of the assessment.

Bond et al. (2012) argue that the sustainability assessment processes need to:

- address sustainability imperatives with positive progress towards sustainability;
- establish a workable concept of sustainability in the context of individual decisions/assessments;
- adopt formal mechanisms for managing unavoidable trade-offs in an open, participative and accountable manner;
- embrace the pluralistic inevitabilities of sustainability assessment; and
- engender learning throughout.

Ness et al. (2007) divide sustainability assessments into three different main categories: indicators/indices, product-related assessment, and integrated assessment tools. Here, indicators are statistically accumulated data from different sources deemed relevant for the task; product-related assessment are ways of asserting if a specific product, based on the indicators, is desirable or not seen in an environmental perspective; integrated assessment tools are used more on a policy level in relation to issues connected both to nature and to society.

Both Bond et al (2012) and Ness et al. (2007) conclude that to consider sustainability in integrated assessments demands that the assessment is anticipatory. This is also given by the focus on future generations in the concept of sustainability development. The normative demands in the concept of sustainability creates a situation where the range of policy options are diminished since an assessment tool that sets thresholds will rule out some of the options as non-viable.

There are several ways of identifying sustainability as a trend in the collected assessments. The obvious way is to be informed by the title or ambition of the assessment and the ways they frame sustainability. In the case of biofuels, we can see that the Nuffield Council of Bioethics (2012) addresses environmental sustainability, distributive issues and human rights. In such a case where all the three aspects of sustainability are considered, we will say that sustainability can be identified as a concern and trend in the assessment. Many of the assessments in the advisory domains raise issues regarding the environment, social issues or the economy, but few consider them all together.

Sustainability is not only a topic for designated sustainability assessments, though. Almost all assessment domains may potentially relate to this trend. When the mandate of an assessment includes considering sustainability, this affects both the methods and the aims in the advisory domains due to the particular threefold definition of sustainability:

- Risk assessments need to integrate economic, social, and ecological risks
- Economic assessments need to integrate (or translate) non-monetary costs (and benefits)
- Impact assessments need to reintegrate the division between environmental, economic and social impact assessments

In the economic domain progress has been made towards widening out the factors that should be included. Ecological economics offer rich resources for addressing a wider range of sustainability issues.

The integration of sustainability into more firm institutionalised settings can also be found in the developments of Impact Assessments as seen in the EC IA (see EST-Frame deliverable 1.1). However, European impact assessment is also motivated by the Better Regulation policy, so European Impact Assessments should not be regarded as purely sustainability focused. However, the current established impact assessment system can serve as an institutional basis for a development towards designated sustainability assessment committees. The Intergovernmental Panel on Climate Change (IPCC) might serve as one example of how transnational committees dedicated to issues concerning sustainability are given prominence by NGOs and states alike in submitting data both on the changes and the human and ecological effects of climate changes. If sustainability is strengthened as a policy trend a possible development might be the establishment of cross-sectorial sustainability committees, performing more institutionalised sustainability assessments.

All reports on sustainability share considerations on the necessity of changing policies. One example on the impact of sustainability in technology governance can be found in the EU's policy on biofuels:

The increasing worldwide demand for biofuels and bioliquids, and the incentives for their use provided for in this Directive, should not have the effect of encouraging the destruction of biodiverse lands. Those finite resources, recognised in various international instruments to be of value to all mankind, should be preserved. Consumers in the Community would, in addition, find it morally unacceptable that their increased use of biofuels and bioliquids could have the effect of destroying biodiverse lands. For these reasons, it is necessary to provide sustainability criteria (Council Regulation (EEC) No 2009/28/EC, 23).

In this decision the EU lays down ecological criteria for land use change and introduction of novel technologies. The biodiverse land is itself considered a public good ("value to all mankind") that the EU will try to save or at the very least not financially support installations that might destroy this land.

Looking at the purpose of the assessment, we can see that assessments that include sustainability and climate change seem to be orientated towards the cognitive aspects of science and policy. Therefore we can infer that sustainability and climate change are mainly addressed in order to understand what they are about, rather than opting for change. A balanced view on sustainability would also include the social dimension as an integrated object in the assessments, but this aspect of sustainability is the most neglected.

From the case studies, we can see that environmental issues are highly important. This is especially the case in the biofuels case study, and environmental aspects are very important also in nanotechnology and in synthetic biology, but when it comes to cloud computing there are only mentions of "greening of the cloud" on a general level. Such an omission of sustainability considerations for ICT can be seen in the reviewed impact assessments where the two assessments

devoted to ICT do not consider sustainability, while the two that assess biofuels do consider it. Economic sustainability is a concern in nearly all reports that have a focus on innovation – regardless of the technology in question.

While environmental and economic sustainability seem to be handled in many assessments, social sustainability appears to be more problematic. The aspects of social sustainability are present in the work on cloud computing through some remarks on "the digital divide"; in the biofuels case there are thoughts about certification schemes to avoid social unsustainable production; in the case of synthetic biology most of the social aspects are centred on biosafety and biosecurity. It is interesting that the *EU Code of Conduct for Nanotechnologies and Nanosciences* include references to the UN Millennium Goals, which must be understood as a measure for social sustainability, while such references are not present in the reviewed nano assessments. Some assessments comment upon the possibility of nano based water cleansing technologies, but without referring to societal issues involved in technology transfers.

With regard to synthetic biology impacts related to sustainable development are relatively underrepresented within the reviewed assessments compared to other analysed impacts. Although it is believed that synthetic biology could potentially contribute by tackling several sustainable development challenges, empirical evidence of such contribution is still lacking. In fact, some actors (e.g. NGOs) are worried about the potential negative sustainability impact synthetic biology may have.

From our studies, we have not found in any of the reviewed domains a method that specifically addresses sustainability (including climate change). In several of the domains sustainability is clearly present, as in impact assessments. However, when reading the assessments, it is often unclear what kind of value is given to sustainability or climate change in practice.

From the EST-Frame studies it seems that sustainability is not included in any systematic manner, but rather depending on the perceived character of the emerging technology. Except for the case of biofuels, where nearly all assessments focus on sustainability, the trend is influencing the way assessments are framed regarding the content, but maybe not regarding the methods that are chosen. As itself an integrative concept, this implies a need for better integrative methods (see chapter 4).

Addressing the issues of sustainability and climate change in assessments has a structural similarity with including PPPs: Both these trends concern how technology is implemented in society and they both have consequences far beyond the imagined technology at an early stage.

Not all emerging sciences and technologies are in a state where they can or should be assessed in relation to sustainability. There are several applications of human biotechnology, as gene therapy, where such assessments would be futile. Highly theoretical potential technologies could be difficult to assess with regards to sustainability since they have no known history of impacts.

Summary

- Sustainability figures as an overarching value in many policy documents, but appears hard to operationalise in assessments. Sustainability is considered to some extent in all domains, but the lack of a broad approach to sustainability, and especially social sustainability, is a striking similarity.
- The social pillar of sustainability appears to be the one with least systematic instruments for operationalisation.
- Sustainability is in itself an integrative concept, but none of the reviewed assessments demonstrates such integration.
- Assessing the sustainability of technology options in practice is a 'downstream' issue. It is crucial to have assessments that also address such downstream issues in its rich complexity.
- Sustainability is important in all cases except cloud computing.
- The main implication for integration is to address sustainability in a broader manner and not just related to direct environmental impact, but as a social phenomenon.

3.7. Economic change

The global economy is currently marred by recession, a fact which influences and shapes virtually all political decision making. As such, the recession is a determining contextual factor of great importance for any attempt to inform policy development processes, including assessments of emerging science and technology. From the perspective of science, it is tempting to think that the crisis must be a transitory phenomenon isolated to the hustle and bustle of politics and with little risk of seriously influencing the slower and steadier processes of scientific discovery and innovation. This perception, however, may be a dangerous illusion. We know from history the depth of the waves, which may be set in motion by financial crisis. Some historians would argue that WWII and perhaps even the entire 'long world war' (WWI, II and III (Cold War)) was fuelled by the collapse of an era of relative stability in global financial systems (Polanyi 1944, Hobsbawm 1987; 1994). During the ensuing times of military competition, scientific discovery and development was harnessed to produce the atom bomb, the long range missile, and the early Internet – just to mention a few landmarks.

Certainly, war is a far-off scenario in the current political climate. Nevertheless, the transformative power of the crisis with regard to technological development may prove to be of similar proportions. A perceived acute nature of the crisis produces a strong incentive to focus research and innovation policies on developments with the potential for short-term positive impacts on the economy. Longer term reflections about the societal desirability of new technologies may be pushed in the background and critical assessment of possible negative impacts may be prioritized lower.

We see such a trend quite clearly in the case study on cloud computing where a strong wave of hype assessments produced or commissioned by industry in the early years' of the technology's diffusion (from 2006 onwards) has managed to frame the issue in such a way that economic gains stemming from cloud computing – although largely unsubstantiated in the literature – remains a central assumption for producers and legislators alike. The case study was even able to document a highly

questionable promotion and acceptance by actors in the field of two economic papers written by one author seemingly validating this assumption (see deliverable 5.1) without any of the quality assurance mechanisms traditionally involved in critical assessments.

However, in the case of biofuels 15 out of the 20 reviewed assessments had an anticipatory character and out of these 15 seven had a horizon of more than 15 years. Indeed, many of the anticipatory analyses considered scenarios towards 2030 or 2050. There is a tendency for assessments to assess biofuels' economics and security impacts (e.g. prices and security of food and fuel) in order to consider their knock-on impact upon environmental or societal impacts (e.g. poverty or carbon emissions). Reversely, the need for immediate growth results from innovation investments may also lessen the incentive to invest in long-term development efforts – even those with great potential for profitability in the long run. In the case of synthetic biology we can see the same pattern as in biofuels where the reviewed assessments are anticipatory and with a majority also considering economics and security impacts. Also in the case of nanotechnologies in the food sector the chosen assessments are anticipatory, but with uncertain time horizons. The absence of inclusion of the economic impacts in the case studies on nanotechnologies in food then seems like an anomaly, but a common assumption behind assessing nanotechnologies in general is that the potentially big gains to be harvested from nanotechnology, along with potential significant risks, there is a perceived need to carry out different kinds of risk assessments, impact assessments, economic assessments, ethics assessments, and so on.

While it is true that the economic crisis may reasonably be viewed as a short-term phenomenon in itself, the long-term consequences of the choices made during this intermediary period may prove to shape the technological course of the 21st century.

Timeline

The timeline of the current economic crisis begins in 2007 where the risks connected to new innovations in real estate financing gradually became apparent. During the 00's, complex derivative financial products had emerged around real estate financing. These derivatives created a highly opaque network of risk sharing mechanisms, which ultimately spread the risk of massive subprime lending throughout the entire global financing system. These mechanisms combined to create a 'bubble' of speculation-driven growth in the economy, which – as it turned out – was bound to collapse. In September 2008 financial giants Fannie Mae and Bernie Mac, which had guaranteed thousands of subprime mortgages, were bailed out by the U.S. Government. Immediately thereafter, the biggest bankruptcy in U.S. history was filed by its fourth-largest investment bank, Lehman Brothers prompting worldwide financial panic (Kingsley 2012). Banks across the Western world tethered on the brink of collapse, and a wave of government bailouts were set in motion.

During 2009 recession set in throughout the entire world economy. Some countries, among them the U.S. reacted with a mix of stimulus packages to help drive economic growth and austerity measures to ease unnecessary economic burdens. Other countries and regions, among them the E.U., focused singly on austerity measures. As a consequence, the Eurozone's weakest economy was affected with double severity by the crisis rolling through the system. In April 2010, Greek debt was downgraded to

'junk' status indicating a lack of trust from financial markets in the ability of the Greek economy to make its payments in the immediate future. This lack of trust threatened the whole Eurozone, as a lack of trust in one of its members could easily translate into a lack of trust in the entire Euro-system. Consequently, a European bailout was designed for Greece with further austerity measures attached as a precondition. This model was applied in a number of European bailouts which followed (of Ireland, Portugal, Spain, Greece again, and most recently Cyprus). European austerity policy continues to this day, still without any positive effects on economic growth (Zacune 2013)

Implications for assessment

One particularly illustrative example of the general effect of the financial crisis on the assessment-policy relationship was seen during the onset of economic recession during diplomatic preparations for the UN COP15 summit in Copenhagen 2009. This summit was designed to be the point at which the nations of the world would finally come to an agreement on a common strategy for curbing CO_2-emmissions. With the so-called Bali-roadmap, much of the diplomatic capital invested in the UN's system for handling climate change was put on the line as part of a gamble that this time, the nations would have to get it right. Since emissions of CO_2 and other greenhouse gases is tied to almost all core activities of industrial development – from energy production to transport, forestry, husbandry and industrial activity – such an agreement would have had a massive impact on the course of technological development. Many advocated a 'second industrial revolution' driven by a transition to green technology.

The summit and its decision-making processes were supported by some of the most thorough assessment work in history. The UN's panel of climate change experts made a momentous effort to gather all the necessary evidence to support scenarios of possible futures connected to different levels of CO_2 emissions. And they orchestrated a strategy of clear communication to make it clear that despite a myriad of disagreements and uncertainties, entire community of climate change researchers stood behind the core recommendation to limit temperature increases to 2 degrees Celsius since the consequences of global warming beyond this limit would grow from horrendous to insurmountable.

Despite these efforts, during 2009 the onset of economic crisis tipped the diplomatic scales, and a non-committal agreement was reached, which fell far short of the ambitious common action plan some had strived for. Clearly, many different factors played into this result. But it was clear to most observers that immediate concerns over the stability of the economic system stole both focus and parliamentary support in many countries away from the UNFCCC process.

The point of recounting the UNFCCC case is simple: even the most clear-cut assessments with the strongest recommendations for political action to reach long-term goals may fall on deaf ears when immediate economic concerns come to the fore in the political arena.

We saw in the case study on cloud computing how economic assessments claiming to document potential growth given a swift societal introduction of cloud computing were given remarkable attention in the policy formulation process while not critically exploring whether issues like 'leap-

frogging' (to jump over stages in a theoretically perceived technology development) and 'the greening of the cloud' or issues of 'dematerialization' are realistic expectations. See EST-Frame delivery 5.1 for further elaboration on these points. Both synthetic biology and nanotechnologies in food production are perceived to be connected to GMO and the public opposition to this – and have been object for what Kaiser et al. (2010) call an "assessment regime". We have, however, also seen specific alternative perspectives such as privacy research and advocacy work forcefully and strategically to counter the effects of this attention to economic arguments.

Summary

Based on a general overview of the case studies in EST Frame, the following conclusions about the impact of economic crisis on assessments of EST can be – tentatively – drawn:

- Supporting innovation and EST is supposed to be an important strategy for leading Europe out of the economic crisis. This means that there is an important 'push' for innovation. Societal concerns may be regarded as a barrier for innovation, instead of being the values driving innovation. The point of public participation in technology assessment and governance may then easily be to ensure public acceptance of EST, rather than taking the input from the public as giving the premises for the development of our society. There is therefore a threat that public deliberation in EST assessment effectively only is 'window dressing'.
- Stakeholder involvement in assessment has been an important way to ensure real world, practical experience into assessments, and also to include the stakeholders' concerns into consideration. However, given the large difference in economic resources accessible to different stakeholder groups there is a risk that stakeholder involvement largely becomes industry involvement. NGOs typically have little time and resources for being engaged in different technology assessment and governance activities, and with the economic crises many experience that public funding is harder to access.
- Whole assessment domains may be affected by the economic crises in the very practical way that public funding is cut. Public TA and ethics offices may have reduced allocations because of fiscal concerns. In some cases, such offices may seek funding other places. However, with funding from industry or other organisations expectations from these funders might influence (explicitly or implicitly) on the work of these offices.
- Reducing funding to such technology assessment offices may also be convenient for silencing potentially critical voices in a time where technology optimism is sought.

3.8. Quantification

Perhaps as a consequence of increased liberalisation we find in current technology governance processes and practices – especially on the European level – an increasing importance of numbers,

models and quantitative data which seem to be more and more seen as providing the "hard" or "real" evidence, in contrast to any other results based on more qualitative approaches and analysis. This tendency to value quantitative evidence more than qualitative evidence we refer to as quantification.

We did not consider quantification as one of the main trends because it has a narrower scope than the megatrends identified in the trends reports we have based our trend selection on. Moreover, the observation we made so far can neither be based on many references from the literature nor validated by systematically collected empirical data. Nevertheless, we think that if our observation is right, this is a contextual factor that does affect technology governance in general and the assessment of emerging science and technologies in particular.

Quantification in technology governance seems to fit in a much broader picture that in the literature is referred to as "governance by indicators" (Davis et al. 2012) or as the performative role of numbers in transnational governance (Hansen & Porter 2012; for an overview see also Espeland & Stevens 2008). However, this is a very emerging research field (Hansen & Mühlen-Schulte 2012). Although not debated much in the literature, many researchers being involved in assessment and foresight projects on emerging technologies feel that the dominant policy culture especially in the European Commission but also in several countries is increasingly focussing on numbers and models.

For instance, in the "Impact Assessment Guidelines" of the European Commission it is clearly stated: "The more quantification you can provide, the more convincing the analysis will generally be." (EC 2009b, 32)[5] In the report for 2012 by the Impact Assessment Board, key trends in the Board's opinions over the years were identified (EC 2012b, 21). According to that, in around 42 % of the reports in 2012 the Board asked for more quantification of costs and benefits, "in order to strengthen the arguments presented in the comparison of options. This […] represents a significant increase on the previous year." (EC 2012b, 22) We take this as evidence for our observation of quantification.

Some more qualitative evidence derives from one of the foresight processes analysed in deliverable 1.1. One of the experts that were involved in the European advisory process of "Global Europe 2050" (EU DG Research and Innovation 2012) argues that several members of the expert group would have preferred a more qualitative approach to the scenario building carried out in the process and that they were ready to contribute their substantial knowledge within the dimensions discussed. However, due to the rigidity of the modelling approach, this was not possible. Therefore, much of the group's potential remained unharnessed.

Implications of this trend

5 It must be mentioned, however, that a few pages later it is also stated: "Do not overlook impacts that cannot readily be expressed in quantitative or monetary terms." (EC 2009b: 38)

Out of the six advisory domains that were analysed in deliverable 1.1 – technology assessment, impact assessment, risk assessment, ethical assessment, foresights, and economic assessment – only the domain of ethical assessment seems to be clearly free from the risk of quantification. On the other hand, the two domains of economic and risk assessment are dominated already traditionally by quantitative approaches. If now also the domains of impact assessment, foresights and finally even technology assessment were focussing more and more on quantitative approaches neglecting the qualitative approaches the whole field of technology governance advising would end to be clearly biased to the quantitative way of thinking. It goes without saying that this enormously affects the methodological choices within a particular assessment process.

Behind the described quantification tendency we see the (quite understandable) attempt of policy and other decision makers to eliminate uncertainty and gain credibility. However, relying on quantitative methods alone restricts our ability to accept uncertainty and to deal with it in a creative way. Besides, other types of knowledge cannot be integrated. In other words, there is a danger that we give up a crucial knowledge source for the sake of a rather delusive certainty. The tension between the widespread wish of politicians (and of the wider public) to have scientifically supported clarity on the one side and the scientific experts acknowledging the uncertainties on the other side is one of the most difficult challenges when trying to close down processes of assessing emerging science and technologies. In our experience for instance, the experts who participate in workshops on problematic aspects of emerging technologies feel this tension very well, even hesitate to score their opinions, believing that this is too tight and maybe even being afraid that the quantitative evidence they might provide could be misused later on in the policy process.

Summary

- Quantification is increasingly requested in order to mask uncertainties and gain credibility.
- Though quantification has a legitimate place in assessments, it is crucial that the numbers are appraised with regard to quality and positioned in their appropriate context.
- Quantitative and qualitative approaches both are valuable in different research and assessment settings. One should not be generally favoured over the other.

3.9 Policy integration as a response to the trends

Coordination and policy integration represent a longstanding challenge not only for the governance of science, technology and innovation (STI) policies, but for the effective management of structures and processes within the public sector per se. The need for coordination, coherence and consistency goes hand in hand with the processes of increased specialisation and organisational differentiation within the public sector (Thompson 1967; Mintzberg 1979) and is a response to all the trends identified above. In addition to organisational differentiation of modern bureaucracies creating the need for more coordination, the growing interrelatedness of economic and societal problems of the past decades increasingly requires policy responses that cut across established institutional boundaries of government departments and agencies.

Next to the objective to regain governing capacity, coordination of public institutions and policies typically tries to reach two main goals (Painter 1981):

1. Efficient and cost effective government
   - Avoidance or reduction of duplication
   - Avoidance of inconsistent and contradictory activities
   - Minimisation of political and administrative conflicts
2. Coherent decisions and policies
   - Achieving thematic coherence and agreeing on accepted priorities among the relevant actors
   - Facilitating a holistic perspective in order to counter particularistic and sectoral interests

In order to identify how STI policy coordination could be enhanced, three analytical steps are required: (a) identification and understanding of coordination-affecting trends, (b) reaction of (STI) policy on such trends, and (c) the impact of such reactions on trends and policy accomplishment.

Identifying and making sense of trends that affect policy integration in the area of STI policy – both positively and negatively – is a challenging task not only due to the lack of unambiguous indicators. More importantly, observable developments and dynamics in policy and governance of STI are the result of a complex interplay of often contradictory, overlapping and deferred past and current trends, rationales emerging from the dynamics of the policy area itself, the evolution of the cognitive underpinnings of the relevant policy communities and their corresponding policy narratives, and external factors putting pressure on actors and institutions to adapt or respond.

One of the major unintended consequences of globalisation and NMP reforms was that governments partly lost their capacity to effectively steer the policy process towards the desired policy goals (Braun 2005; Matthews 2011). The aspiration to regain sufficient governing capacity within the fragmented policy arenas can at least partly explain the growing attention directed towards coordination and policy integration.

A great deal of the institutional reconfigurations of the publicly funded science and research sectors throughout the OECD world of the past were inspired by and designed along the lines of NPM, thereby fundamentally changing the governance of STI, and creating very similar unintended consequences as was the case in public management per se.

Towards mission orientation

Related to the increased importance of the public's position within scientific and technological developments, research in the STI field has observed shifting boundaries between science and politics that have resulted in new approaches to the governance of STI (Lengwiler & Simon 2005). After a phase of so-called 'blind delegation' in the post war period during which science enjoyed a comparatively high degree of autonomy, the relationship between politics, society and science has been subject to processes of redefinition since the 1970s/1980s.

The aim of these reconfigurations was to make publicly funded research and science more accountable to governments and the public at large. The increasing demand of STI policy-makers for

legitimisation of publicly funded research resulted in growing political pressure particularly for basic research. As a reaction to the observed changes in the relationship between science and government, there are increased attempts of politics to define certain goals for the STI areas[6]. Accordingly, the demand for integration and coordination of STI policy has significantly increased in the last few years due to the strategic mission-orientation. Mission-orientation includes as well the supportive nature of science towards non-scientific goals including economic growth as a new emphasis on the so-called 'grand challenges' of contemporary societies, such as climate change or public health. No doubt, the policy objectives related to such mission-orientation are highly complex and span a large number of sectors and institutional boundaries, cutting across established thematic and disciplinary areas, bureaucratic lines, actor groups and subsystems. The requirements for improved policy integration and coordination are obvious if STI policy is to be geared towards increased responsiveness to societal demands.

Based on numerous global trends affecting economic and social structures, the need towards increased coordination and integration has become apparent. During the past decade, a new emphasis on coordination and improved public management in general could be observed in the OECD world (Bouckaert et al. 2010). In fact, a growing number of governments have started to generally refocus on coordination of policy and public management in the last few years. These so-called 'whole-of-government' initiatives such as 'joined-up government" in the United Kingdom, 'horizontalism' in Canada or 'reviewing the centre' in New Zealand all have in common an increased focus on horizontal collaboration and policy integration between different government departments and levels, public organisations and agencies (Bouckaert et al. 2010).

Policy integration can be categorised by being either institutional developments or scientific conceptual frameworks able to facilitate (STI) policy making. Concerning the institutional developments, we will discuss the movement towards governance and the implementation of the Open Method of Coordination. Discussed scientific conceptual frameworks are the system of innovation heuristic and the concept of responsible research and innovation, both gaining momentum in national and international public institutes.

From government to governance

The government to governance process could be assessed as being a reaction to increased public engagement and institutional fragmentation. The role of the state vis-à-vis society and economy and its ability to reach certain objectives is subject to continuous change and reconfiguration. At a very general level, political science has observed that governments in developed countries have lost much

6 One of the most prominent manifestations of this problem- or need-oriented approach is the European Union's Lund Declaration of 2009 (http://www.se2009.eu/polopoly_fs/1.8460!menu/standard/file/lund_declaration_final_version_ 9_july.pdf). Along similar lines, the German Hightech-Strategy, which was introduced in 2006 and renewed in 2010, attempts to address global challenges with a mission-oriented and cross-cutting approach (BMBF 2010).

of their former – either perceived or factual – capacity to effectively steer other social subsystems in the past decades. This very broad development has been coined by terms such as the "cooperating state" or the "negotiating state". In effect, governments rely less on traditional forms of hierarchical, top-down "command and control" steering and increasingly have to depend on cooperation, negotiation, moderation and consensus building in order to fulfil certain functions. Dialogue and participation of non-governmental actors is being increasingly put at the centre of STI governance (Callon et al. 2009; Meister and Dienel 2010).

This emphasis on *governance* as opposed to traditional *government*, and the associated focus on the management of interdependencies between collective actors as well as the application of a dynamic mix of different regulating mechanisms (hierarchy, markets, majority rule, negotiation, networks) can be observed in most policy areas (see Benz 2004; Bröchler & Blumenthal 2006; Mayntz 2006). In short, governance puts special emphasis on the importance of cooperation and co-action of private and governmental actors in processes of public problem solving (Bröchler 2010).

The far-reaching trend towards governance instead of government has a number of implications for policy integration and coordination in the STI areas. No doubt, the task of effective coordination and the formulation of integrated policies have become much more challenging for governments in the face of dynamic and complex contexts with weakened hierarchical relationships and the requirement to simultaneously apply different modes of interaction such as cooperation, negotiation, moderation and consensus building. However, in the area of STI policy it seems that many governments have responded to this challenge by reforming institutions and establishing new processes with the aim to improve coordination and policy integration.

Nevertheless, the question is raised whether established governmental institutions and their processes are 'fit-for-purpose' to meet these requirements of modern governance. Political institutions are often criticised for being too narrow in their policy focus, hierarchical in their operations and departmentalised in their orientation, resulting in fragmented instead of integrated policy approaches (Edler et al. 2003). An additional challenge relates to the involvement of public involvement. If taken seriously, with public involvement an influential factor is added to the STI arena, increasing complexity and reducing government's capacity of directing technology trajectories. On the other hand, the power relations within the existing institutional configuration of the STI arena will need to be reconfigured. For example, the established functions of ethic commissions and other advisory bodies will most likely have to be re-balanced vis-à-vis the role of participatory processes.

European integration and the Open method of Coordination

European integration and the Open method of Coordination could arguably be observed as a reaction to globalisation and the subsequent need to align and coordinate fragmented national policies. The common European strategic response is to foster the development of the 'knowledge society' in order to support economic growth and international competitiveness (cf. Mejlgaard et al. 2012). In this sense, high-level European policy strategies such as the Lisbon Strategy of 2000 are the endeavour to stimulate innovation systems, and this, in turn, requires regaining governance

capacities to effectively coordinate and integrate STI policies. From this perspective, the EU's Lisbon Strategy seems to have provided a common point of reference for policy debates in several countries, thereby unfolding integrating tendencies in STI policies to a certain extent.

With the progressing European integration, a growing number of responsibilities and policy areas have been transferred to the level of the European Union, while a set of competencies remains part of Member States' sovereignty. As a result, a complex system of multi-level governance, marked by vertical distribution of (partly shared) responsibilities between the supranational, national and sub-national levels of government has emerged and is still in the making. Those policy areas that fall under the responsibility of the EU according to the treaties clearly have been subject to unifying tendencies. However, a number of policy areas within the EU can only be jointly governed based on intergovernmental agreements. In order to improve compatibility, consistency and policy coherence even in those policy areas that are primarily national jurisdiction, a new method of governance was introduced in the EU: the Open method of coordination (OMC). Since 2000, the OMC is a codified element in the treaties and has since been applied to a growing number of policy areas, including education and research policy (Borrás & Jacobsson 2004).

The OMC uses elements of 'soft law' in order to reach its coordination goals. The main mechanisms include the development of guidelines for the Member States, using indicators, monitoring, benchmarks and best practice examples in order to improve the shared information basis (but also provides for 'naming and faming or shaming'), and target setting. In short, OMC relies on mutual learning and the convergence of ideas as the chief coordination mechanism (Gornitzka 2005).

The Systems of Innovation heuristic

The systems of innovation approach could be seen as a reaction towards both the internationalisation of markets and the required combining of fragmented institutions. At least since the late 1990s, the innovation system approach has established itself as the most influential paradigm within the international innovation policy research community. The systems of innovation perspective does not only frame the scientific debates dealing with innovation, it also provides conceptual orientation for many governments and international and supranational organisations such as the OECD and the European Union (Fagerberg & Verspagen2009; Lindner 2010).

The chief proposition of the IS approach is that innovations are the result of interactive and interdependent processes in which various actors from different subsystems participate. Accordingly, innovations do not occur in isolation within a single firm. Instead, innovation is understood to be a collective and collaborative process spanning across sectors and subsystems (Edquist 2005).

Consequently, the IS approach puts special emphasis on ensuring well-functioning processes of exchange and collaboration between different actors and subsystems. In order to meet these demands, STI policy needs to be designed in such a way to ensure the bridging of the often fragmented institutional landscapes and to effectively enable horizontal and systemic coordination of actors and policies.

Responsible Research and Innovation

Responsible Research and Innovation (RRI) is an attempt to address issues of mission orientation, public engagement and institutional fragmentation. RRI has been defined as an interactive process by which social actors and innovators become mutually responsive to each other with a view on the acceptability, sustainability and societal desirability of the innovation process and its marketable products (European Commission Services, 2011). Within RRI, both a product and process dimension can be distinguished. Concerning the product dimension, environmental protection, human health, sustainability and societal desirability are normative anchor points that need to be taken into account within product evaluation and design. Concerning the process dimension, a multi-disciplinary approach with multiple stakeholders should lead to an inclusive process leading to responsibility by both the innovator and the actors participating in the co-creation process. In this respect, RRI could be observed as an extension of the movement towards governance (European Commission Services, 2011).

Several deployable methods have been suggested to implement RRI. From the product dimension, these include the execution of institutionalised technology assessment and foresight studies, the application of the precautionary principle and the use of demonstration pilots. From the process dimension, approaches include code of conduct development, the assurance of market accountability and the moderation of public debate (European Commission Services, 2011).

Findings from the case and domain studies

Approximately half of all cloud computing assessments reflect on the issue of policy integration, and the majority of these assume that this is relevant for the cloud computing domain. The majority of biofuels assessments do not reflect on the issue of policy integration and are unclear to what extent policy integration is an important issue within the biofuels domain. However, when the assessments reflect upon the policy integration, they always assume that this trend is relevant for the biofuels domain. In biofuels policy integration is considered more reflexively than other trends, although the counter trend of non-integration is most often assumed. This is generally considered an issue to rectify, with some assessments referring to the need for a more integrated approach to the assessment and management of biofuels development (e.g. Scarlat & Dallemand, 2011). In a way, this reflects that integration is on the horizon of assessment practitioners but has not made headway into the domain of biofuels assessments. The mode of integration discussed varies significantly, e.g. with broader agricultural, environment, energy, forestry, development and/or transport policy.

The large majority of nano-food assessments do not reflect on the issue of policy integration. The majority of assessments are unclear to what extent policy integration is an important issue within the nano-food domain. However, when assessments reflect upon the policy integration, the majority assume that this is relevant for the nano-food domain. However, in the Netherlands, nanotechnology in general is being discussed at an inter-department-level in order to monitor all developments regarding this technology. In this respect, it looks that the trend policy integration is relevant and observable, at least in the Netherlands regarding nanotechnology assessments. As with nano-food assessments, the large majority of synthetic biology assessments do not reflect on the issue of policy

integration. It is not clear if policy integration is (a) present vs. absent, or (b) required vs. non-required. A relative majority of synthetic biology assessment is unclear to what extent policy integration is an important issue within the synthetic biology domain. However, when assessments reflect upon the trend policy integration, the majority assume that this trend is relevant for synthetic biology.

In the domain studies policy integration is assumed reflectively in nearly half of the reviewed assessments, though there are differences between the domains. The impact assessments reviewed all consider and assume policy integration. On the opposite side, the question of policy integration does not seem to be of relevance in the reviewed economic assessments. In the other domains, there are no clear patterns.

Summary

In order to assure the sustainable development of science, technology and innovative behaviour, there are indications that STI policy making is responding to several global trends affecting the behaviour of societies and economies. However, it is unclear if the observed reactions identified so far prove to be sufficient. There seems to be little evidence to what extent the observed reactions actually improve the output of STI policy. Concerning the movement towards governance, it is unclear if the current institutional structure is fit to facilitate such a change in a sustainable manner. This relates as well to efforts being made to align heterogeneous institutions. Although there is little evidence of the effects of OMC on research policy, much of the high hopes related to OMC have been sobered due to Member States refraining from engaging in the logic of benchmarking. This also accounts for a number of other coordination instruments and processes similar to OMC practice within the European Research Area.

In the review of the assessments we looked for discussions of policy integration. Biofuels is the case study where policy integration is to the largest extent considered reflectively. Moreover, in the biofuels case study, policy integration is the trend that is most often considered reflexively, although it is generally referred to in the context of the need for a more integrated approach to the assessment and management of biofuel development (Scarlat & Dallemand, 2011). However, as we have seen in the above description policy integration is a many-facetted topic, and the protocol did not cover all these dimensions. We can still make some tentative conclusions with regard to technology advising in general.

- Different modes of knowledge production are not being addressed in a systematic manner. There are little indications that public institutions are reacting in a pro-active manner to the upcoming movement of open innovation, or that this is considered an important topic for assessment.
- The innovation system approach acknowledges a number of actors having different functions in developing and diffusing innovations. Taking such an approach seriously involves targeting more decision makers and stakeholders in assessments; in particular assessments that intends to create awareness and influence decisions. Stakeholder involvement may therefore need to be more systematically considered in assessments; both for providing relevant

input/information to the assessment, but also for engaging with potential users of the assessment.

- Responsible Research and Innovation is, as described above, supposed to be a system-wide approach, making all parts of the innovation system responsible. Assessment actors and advisors have themselves important functions in the innovation system, assisting in the development or governance of the innovations. This requires increased transparency, reflexivity and responsiveness also on the side of the assessors.
- When governance takes an increasingly prominent role, assessment actors need to engage in larger governance networks, sharing their knowledge, but also being challenged on their functions in the innovation systems. This holds for all the assessment domains, including seemingly purely technical assessments as risk assessment.
- Finally, the OMC model requires the exchange of best practices. This is only possible if assessments are transparent in the framing, assumptions and method choices. Increased transparency and better comparability seems therefore to be a requirement is policy integration if to be achieved.

4. Implications for current and future frameworks for assessing emerging science and technologies

In the descriptions of the trends above the way in which these trends are treated in assessments from the case and domain studies have been examined. This analysis does not claim that all the trends are relevant in all assessments, but that responsible EST governance needs to take the trends into account. As such, reflexivity about the impacts of such trends on their particular EST issue will strengthen the assessments' relevance as part of the evidence base for policy. Impact assessments are already good at including such reflection. The other advisory domains also have resources to do this, but might be encouraged to do this more systematically. Such systematic reflection may at the same time make them better equipped to deal proactively with effects of these trends on their own conditions of work.

There are three ways that the advisory domains can respond to the trends:

1) They can discuss the effect of the trends on technology governance
2) They can adapt their methods to the trends in order to have more impact on technology governance
3) They can be more transparent about their assumptions, about future predictions and how the trends influence on topics they address (e.g. ethical issues, economic projections, technology development, etc.)

This section starts with a summary of the concluding points from the descriptions above, including reflections on their implications for EST assessment and governance. The implications of the previous discussions for the potential of a more integrated approach to EST assessments and some ways such

a framework needs to respond to these trends is then discussed. The strengths and weaknesses of the methods and approaches in this study are identified and discussed. Finally, general recommendations are presented that respond to the need to recognise the role of trends and contextual factors in technology advising and governance.

4.1. Main lessons from the analysis of the domains and cases

The following points have been drawn from the analysis of the domains in the earlier chapters:

Liberalisation and globalisation

Liberalisation and globalisation is a trend with great importance for governance and assessment of emerging science and technologies. The trend implies that assessments will be commissioned by other parties rather than national governments and this will have implications for the framing of questions for these assessments. Examples of such implications would be:

- A shift in focus from the overall public good to marketable products (private companies) and single public issues (NGOs);
- A shift in focus from wordy policy documents to practical advice;
- A shift in balance between opening up and closing down societal dialogue;
- A shift in definition of clients, stakeholders and shareholders;
- A shift in balance between democratic disclosure and competitive non-disclosure;
- A shift in focus from whether an innovation is socially acceptable (static) to how an innovation could become socially acceptable (dynamic).
- Liberalisation and economic globalisation implies that markets based assessment mechanisms will be of increasing importance for EST governance. Private consultancies providing such assessment services should to a larger extent be included in discussions about quality and transparency in private assessments.

Moreover, liberalisation may lead to ever increased reliance on economic assessments, at the potential cost of assessments that assume a larger extent of societal steering. Less regulation may mean less risk assessment and less impact assessment. Finally, with a strong liberalist ideology funding for ethics assessments may be reduced.

New governance networks

- New governance networks may be required for addressing new societal challenges, such as climate change. This also implies a need for assessments at, most importantly, a global level.
- Differences in quality are found between national and international assessments, but these vary from case to case. Potentially an important topic, these findings should be further investigated in future research.
- All reviewed TAs and impact assessments assume diversified governance levels. The other domains tend to make such assumptions, but not systematically.

- In biofuels only a minority of the assessments included internationalisation. In the other cases this trend was present

Public-Private Partnerships

- PPPs are rarely addressed in assessments, even if they are put forward as important policy measures in official policy, especially in the EC.
- The manifestation of technologies in practical policy initiatives, such as PPPs, need to be addressed at some stage in assessments of new and emerging technologies.
- PPPs strengthen economic concerns in STI policy. It is important that these are balanced with also non-economic assessments.

Citizen empowerment and democratisation

- Citizen empowerment and democratisation continues to be an important trend in European governance.
- Empowerment of citizens and parliamentarians alike is important for technology assessment.
- Problems related to methodology and real impacts of deliberative approaches remain. Increasingly social diversity makes consensus harder, and may be an incentive for information and labelling measures rather than consensus events.
- Most advisory domains/institutions do not have systematic instruments for including lay people in empowering ways.
- There is no systematic inclusion of lay people in the domains except impact assessment. Risk assessments and economic assessments never include lay people while this might occur – even if it seldom does so – in the other domains.
- In order to avoid the inclusion of a broader audience into assessment as simply a PR tactic, transparency in such mechanisms is important. Standards for transparency should be worked out in order to quality control of the deliberative processes.

Rapid technological change

- Rapid technological change is important as it poses difficult governance problems. Risk assessment and corresponding regulatory processes are slower than the speed of technological change and can often not keep up. Applying the precautionary principle must therefore be considered.
- Informal governance measures, such as codes of conducts and ethics by design principles, have been proposed as more flexible means. However, these must take into account that rapid technological change may affect basic societal values.
- Rapid technological change also poses serious methodological challenges for economic projections, which must be taken into account in the governance of emerging science and technologies.
- The assessed domains are similar in their lack of treating rapid technological change in a coherent way.

Increased focus on sustainability and climate change

- Sustainability figures as an overarching value in many policy documents, but appears hard to operationalise in assessments. Sustainability is considered to some extent in all domains, but the lack of a broad approach to sustainability, and especially social sustainability, is a striking similarity.
- The social pillar of sustainability appears to be the one with least systematic instruments for operationalisation.
- Sustainability is in itself an integrative concept, but none of the reviewed assessments demonstrates such integration.
- Assessing the sustainability of technology options in practice is a 'downstream' issue. It is crucial to have assessments that also address such downstream issues in its rich complexity.
- Sustainability is important in all cases except cloud computing.
- The main implication for integration is to address sustainability in a broader manner and not just related to direct environmental impact, but as a social phenomenon.

Economic change

- Supporting innovation and EST is supposed to be an important strategy for leading Europe out of the economic crisis. This means that there is an important 'push' for innovation. Societal concerns may be regarded as a barrier for innovation, instead of being the values driving innovation. The point of public participation in technology assessment and governance may then easily be to ensure public acceptance of EST, rather than taking the input from the public as giving the premises for the development of our society. There is therefore a threat that public deliberation in EST assessment effectively only is 'window dressing'.
- Stakeholder involvement in assessment has been an important way to ensure real world, practical experience into assessments, and also to include the stakeholders' concerns into consideration. However, given the large difference in economic resources accessible to different stakeholder groups there is a risk that stakeholder involvement largely becomes industry involvement. NGOs typically have little time and resources for being engaged in different technology assessment and governance activities, and with the economic crises many experience that public funding is harder to access.
- Whole assessment domains may be affected by the economic crises in the very practical way that public funding is cut. Public TA and ethics offices may have reduced allocations because of fiscal concerns. In some cases, such offices may seek funding other places. However, with funding from industry or other organisations expectations from these funders might influence (explicitly or implicitly) on the work of these offices.
- Reducing funding to such technology assessment offices may also be convenient for silencing potentially critical voices in a time where technology optimism is sought.

Quantification

- Quantification is increasingly requested in order to gain perceived credibility.
- Though quantification has a legitimate place in assessments, it is crucial that the numbers are appraised with regard to quality and positioned in their appropriate context.
- Quantitative and qualitative approaches both are valuable in different research and assessment settings. One should not be generally favoured over the other.

Policy integration

- Different modes of knowledge production are not being addressed in a systematic manner. There are little indications that public institutions are reacting in a pro-active manner to the upcoming movement of open innovation, or that this is considered an important topic for assessment.
- The innovation system approach acknowledges a number of actors having different functions in developing and diffusing innovations. Taking such an approach seriously involves targeting more decision makers and stakeholders in assessments; in particular assessments that intends to create awareness and influence decisions. Stakeholder involvement may therefore need to be more systematically considered in assessments; both for providing relevant input/information to the assessment, but also for engaging with potential users of the assessment.
- Responsible Research and Innovation is, as described above, supposed to be a system-wide approach, making all parts of the innovation system responsible. Assessment actors and advisors have themselves important functions in the innovation system, assisting in the development or governance of the innovations. This requires increased transparency, reflexivity and responsiveness also on the side of the assessors.
- When governance takes an increasingly prominent role, assessment actors need to engage in larger governance networks, sharing their knowledge, but also being challenged on their functions in the innovation systems. This holds for all the assessment domains, including seemingly purely technical assessments as risk assessment.
- Finally, the OMC model requires the exchange of best practices. This is only possible if assessments are transparent in the framing, assumptions and method choices. Increased transparency and better comparability seems therefore to be a requirement is policy integration if to be achieved.

4.3. Implications for an integrated approach

We have in this report argued that trends are important for the possibility of governance of technologies. From the above studies of how reflection on the influence of the selected trends are included in assessment we find that no domains, except impact assessment, systematically include reflection on trends, though many assessments discuss some trends or assume certain trends in their discussions. This situation warrants, in our opinion, an integrating function. The trends influence the possibility of and instruments for responsible EST governance. As such important factors they need to be addressed in the body of assessments as a whole (related to a technology option). An

integrating function needs to appraise the existing body of assessments in a technology field, and draw out three kinds of knowledge:

1) What assessments do discuss these policy trends (all or some of them) and can this discussion be of use for governance in the field as such?
2) What assumptions on the possibility of governance are made by the existing assessments and are they reasonable?
3) Is there a need for new assessments explicitly addressing the effects of the trends on governance in this field?

This involves positioning assessments within the workings of these trends. What this will involve in practice must be determined in dialogues about such assessments in their context. The implications described in this report therefore needs to be regarded as examples of how to reason from these trends, rather than as quasi-empirical inferences.

In the EST-Frame deliverable 1.3 we argue for a framework for integrated assessment that involves gathering participants from different assessment domains, as well as other stakeholders, in a dialogue about the adequacy of the current assessments for responsible governance and the potential need to expand the evidence base with new assessments, based on considerations of situation analysis and method choice. Such a function may meet the needs for addressing policy trends systematically.

The trends discussed in this report will impact on such integration:

- Liberalisation, PPPs and economic uncertainties may lead to increased focus on economic assessments, at the cost of integrated assessments. However, it would not diminish – but rather strengthen – the actual need for more balanced assessments. Still, we do not observe a strong risk towards such narrowing of focus in the studies in EST-Frame, and believe that such trends are not in principle in the way for a more integrated approach.
- The diminishing role of the nation state may present an additional integration challenge for the assessment of emerging technologies. In addition to integrating findings from different assessment domains, it may be necessary to integrate findings from regional and supranational scales. Unlike national systems of assessment, global actors must consider the impacts of emerging technologies in diverse cultural and physical spaces which may give rise to conflicting social, environmental and economic issues. For example, international technology assessment and governance actors may need to balance the need for economic development in one continent against the impacts of climate change in another, while satisfying market forces and environmental targets in another.
- An integrated assessment framework must have mechanisms for broader involvement, as in such integration normativity cannot be denied. An integrated framework needs standards for transparency, in order to ensure that normative assumptions are openly discussed.
- Taking into account rapid technological change in such an integrated framework would mean to introduce uncertainties on several levels – from the framing and the whole set-up of the assessment to the reflections on the eventual impacts of the advises given. Such reflections

seem to be addressed in the concepts of Responsible Research and Innovation. In this line of thinking, *responsiveness* is seen as a method for not closing a process down prematurely (Owen et al., 2013, 35). An integrated framework must facilitate transparency on uncertainties and the way these are faced and handled.

- Sustainability assessments have integrated elements from different perspectives, institutions, and sectors. Sustainability as a trend will then function as integrative in assessments and governance of emerging sciences and technologies through its substantive ecologic, social, and economic values. With an increased focus on sustainability there will likely be increased interest in integrated approaches. Sustainability is itself an integrating concept and may support the development of more integrated practices in assessment and governance. Sustainability as an overarching policy goal has the potential to form a normative basis for integration in assessments. A focus on sustainability also implies a focus on real life impacts. An integrated framework cannot only deal with mapping abstract issues, but must engage in EST governance issues of a practical character.
- Finally, an integrated framework will be of great value for increased policy integration.

In the EST-Frame deliverable 1.3 the EST-Frame integrated approach to EST assessment is further spelled out and justified.

4.4. Some methodological reflections

The discussions of the implications of the trends have a speculative character. This is hard to avoid. We believe that the discussions still are valuable in our context. For EST-Frame project the value of the trends study have been:

a) To increase the understanding of the policy context of EST assessments.
b) To increase awareness of what assumptions are made about the policy context in the assessments and to what extent they are explicitly included at all.
c) To increase the awareness of the consequences of assumptions of contextual factors in assessments
d) To indicate what dimensions need to be addressed in making sure we have the necessary assessment basis for responsible EST governance. This involves positioning assessments within the workings of these trends. What this will involve in practice must be determined in dialogues about such assessments in their context. The implications described in this report therefore needs to be regarded as examples of how to reason from these trends, rather than as quasi-empirical inferences.
e) To reflect on how trends may influence on the relative significance of advisory domains, on the methods applied and on situation analysis and communication in assessment activities in general.
f) To enable us to determine how megatrends influence the need and design of an integrated approach to assessment.

With this level of ambition we believe that the description of the trends and the discussion of their possible implications are adequately justified by the literature and document searches we have

carried out, as well as the dialogue we have had with practitioners in the field. However, we believe that each single trend merits more investigation.

Furthermore, this study investigated the actual inclusion of trends in cases and domains. Here we used the analytic protocols developed in the project (see annex 1 in EST-Frame deliverable 1.1). There are important methodological challenges with using such a protocol where judgement is required, not least when several evaluators are involved. We therefore developed a detailed protocol, and also organised a calibration group consisting of the researchers that were most involved in the analyses. For the case study analysis, the results were also discussed with practitioners in the field through interviews and workshops. We therefore believe that the general conclusions are relevant as justified observations of the field. However, they are inherently related to our selection of assessments for further analysis. They are also related to the national contexts of the different partners in the projects. We therefore do not generalise our findings, except for stating that some overall tendencies seem to be observable. It is up to the reader to assess whether these tendencies make sense in the particular context (nation, assessment domain, etc.) of the reader.

4.2. Summary and recommendations for policy makers

Greater levels of market liberalisation and public-private partnerships (PPP) seem to indicate increased importance of economic assessments in decision-making. However, economic assessments are not dominating any of the chosen case studies, and PPPs are hardly mentioned. If it is the case that liberalisation is an important contextual factor then the effects of market liberalisation on responsible technology governance should be discussed more widely. Moreover, the economic assessments that underlie policy on PPPs should become more transparent and scrutinised as part of the assessments in EST fields. As liberalisation potentially affects the boundaries of technology governance, we recommend that assessments discuss this reflectively to a larger extent.

New governance networks, especially on an international level, are being considered in assessments. However, because of the global character of the current grand societal challenges, there should be increased infrastructure and competence building for assessment at a global level.

Citizen empowerment has typically been an important element within TA, but impact assessments also include some wider involvement. We recommend that more systematic infrastructure or instruments for the involvement of lay people and a broader range of stakeholders in all assessments is developed. This also means empowering potentially marginal or socio-economic weaker groups (for instance consumer and societal organisations without much financial resources) thus facilitating participation. We also recommend developing standards for transparency in such involvement processes, in order to be able to assess the nature and quality of the involvement.

Rapid technological change implies that significant uncertainties may result, both with regard to environmental and human health risks, and with regard to societal and economic impacts. These uncertainties must be characterised and applying the precautionary principle must be considered. Moreover, such rapid change also affects important societal values. These must be considered and

appropriately addressed in an anticipatory way, so that societal, value based technology governance can be carried out at an appropriate early stage.

Sustainability – and especially its social pillar - can be better operationalised. Sustainability needs to be addressed as an integrative concept, and not split into separate 'silo' assessments that are not integrated. If sustainability is to be an important policy goal, better tools for integration of knowledge need to be developed. Even at a time of 'economic crises', the balance of ecological, economic and social concerns need to be considered, so that unsustainable measures are not used and embedded for short-term gains in the European economy. In such balancing, quantification has a place, but it must be scrutinised and placed within a wider perspective.

Transparency of assessments is crucial for ensuring policy integration. Insufficient transparency about assumptions, methods and the practical aspects of the assessment process comparability is likely to reduce the value and impact of the assessment. Best assessment practices need to be clearly defined and disseminated.

Overall, we have found that the policy trends may have significant impact both on the development of EST, the possibilities for responsible governance of EST and the setups and practices of EST assessment. This merits devoting much more attention to the trends in EST assessment in general and especially in assessment processes that intend to integrate the assessment evidence base in a field into practical, multi-dimensional policy recommendations.

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Annex 1: The trends selection

Organisation	Ernst and Young (2011)	The European Environment Agency (2011)	JRC, IPTS (2010)	EUISS/ESPAS (2012)	OECD (2001)	ICSU (2011)	EC DG Research and Innovation (2012)
Title of report	**Tracking global trends**	**Global megatrends**	**Facing the future**	**Global trends 2030**	**Governance in the 21st Century**	**Report1 International science in 2031 - exploratory scenarios**	**Global Europe 2050**
New governance networks	Governments enhance ties with the private sector	From a unipolar to a multipolar world		Emergence of a polycentric world, shift of power away from states	New governance networks		Changing geopolitics
Rapid technological change	Rapid technology innovation creates a smart, mobile world; disruptive innovation	Accelerating technological change: racing into the unknown				Exponential increase in the rate of technological change; new enabling ICTs	Key enabling technologies; focus on innovation
Increased focus on sustainability		Decreasing stocks of natural resources	The need to change current ways in which essential natural resources are used – due to	Greater stress on sustainable development			Systematic governance of climate change and sustainability challenges;

			the non-sustainable human over-exploitation of natural resources.				sustainable transport
Citizen empowerment				The empowerment of the individual	The end of authority (in government, firms, associations and family), experimentation with democracy; less hierarchical governance institutions		E-action and democracy
Liberalisation/globalisation	Emerging markets increase their global power	Intensified global competition for resources					Accelerating shift of economic power to Asia
Policy fragmentation/integration		Environmental regulation and governance: increasing fragmentation and convergence	The need for more effective and transparent governance for the EU and the world	Governance gaps			
Resource scarcity				Resources scarcity, poverty		Pressure on resources: water, food and energy	More constraint on key resources

Urbanisation		Living in an urban world				Urbanisation	
Diseases		Disease burdens and the risk of new pandemics				Global pandemics and lifestyle diseases	
Demographic change		Increasing global divergence in population trends					A continued imbalance in population growth; Pressure of aging population on public spending
Global human community				Sense of belonging to a single human community			Global connectivity
Economic change		Continued economic growth?			Increased wealth		
Climate change		Increasing severe consequences of climate change					Systematic governance of climate change and sustainability challenges
Environmental change		Increasing environmental pollution load				Global environmental change	