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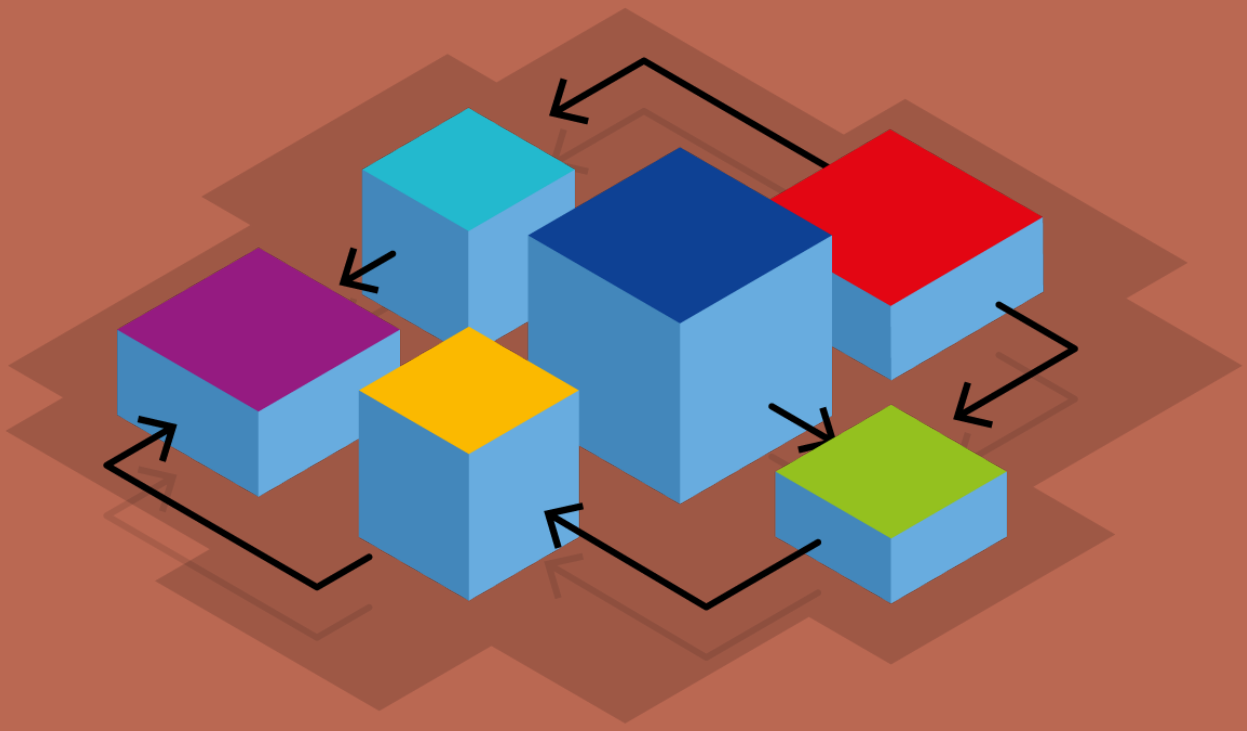

European Cluster Observatory

Foresight report on industrial and clus-ter opportunities

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Internal Market, Industry, Entrepreneurship

European Cluster Observatory in Brief

The European Cluster Observatory is a single access point for statistical information, analysis and mapping of clusters and cluster policy in Europe that is foremost aimed at European, national, regional and local policy-makers as well as cluster managers and representatives of SME intermediaries. It is an initiative of the "SMEs: Clusters and Emerging Industries" unit of the European Commission's Internal Market, Industry, Entrepreneurship and SMEs Directorate-General that aims at promoting the development of more world-class clusters in Europe, notably with a view to fostering competitiveness and entrepreneurship in emerging industries and facilitating SMEs' access to clusters and internationalisation activities through clusters.

The ultimate objective is to help Member States and regions in designing smart specialisation and cluster strategies to assist companies in developing new, globally competitive advantages in emerging industries through clusters, and in this way strengthen the role of cluster policies for the rejuvenation of Europe's industry as part of the Europe 2020 Strategy.

To support evidence-based policy-making and partnering, the European Cluster Observatory provides an EU-wide comparative cluster mapping with sectoral and cross-sectoral statistical analysis of the geographical concentration of economic activities and performance. The European Cluster Observatory provides the following services:

a bi-annual "European Cluster Panorama"(cluster mapping) providing an update and enrichment of the statistical mapping of clusters in Europe, including for ten related sectors (i.e. cross-sectoral) and a correlation analysis with key competitiveness indicators;

a "European Cluster Trends" report analysing cross-sectoral clustering trends, cluster internationalisation and global mega trends of industrial transformations; identifying common interaction spaces; and providing a foresight analysis of industrial and cluster opportunities;

a "Regional Eco-system Scoreboard" setting out strengths and weaknesses of regional and national eco-systems for clusters, and identifying cluster-specific framework conditions for three cross-sectoral collaboration areas;

a "European Stress Test for Cluster Policy", including a self-assessment tool accompanied by policy guidance for developing cluster policies in support of emerging industries;

showcase modern cluster policy practice through advisory support services to six selected model demonstrator regions, including expert analysis, regional survey & benchmarking report, peer-review meeting, and policy briefings in support of emerging industries. The policy advice builds also upon the policy lessons from related initiatives in the area of emerging industries;

bring together **Europe's cluster policy-makers and stakeholders at the European Cluster Conferences** 2014 and 2016 for a high-level cluster policy dialogue and policy learning, and facilitate exchange of information through these webpages, newsletters, videos, etc.

More information about the European Cluster Observatory is available at the EU Cluster Portal at: http://ec.europa.eu/growth/smes/cluster/observatory/.

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1. Introduction

This **foresight report** on industrial and cluster opportunities has been prepared under the European Cluster Observatory. The overall aim of the foresight exercise was to explore new societal, technological and economic trends, as well as the ways in which cross-sectoral collaboration could affect value creation structures, and innovation processes. While the trend analysis of the previous Sections is driven mainly by data analysis, the foresight exercise follows a different methodology and provides an additional perspective on the subject of future industrial and cluster opportunities.

Foresight can be understood as a systematic and participatory process of intelligence gathering and vision building, which is aimed at present day decision-making and mobilising joint action.[1] A major difference compared to forecasting is the work with alternative futures – for example in the form of scenarios – rather than a direct, often linear extrapolation of the past. Foresight assumes that the future is open and can evolve in different directions, which can be shaped to some extent by the decisions and actions taken today. In other words, foresight is an explorative activity supposed to widen the perspective of policy makers, cluster managers and executives of companies or research organisations to identify, interpret and anticipate upcoming issues, in order to prepare for potentially surprising developments, to stimulate dialogue or to forge a common vision among the relevant actors.

The foresight report on industrial and cluster opportunities **aims** to address the following questions:

- Which wider trends in society will shape industrial and cluster opportunities in the future?
- What are the consequences that can be expected for cluster organisations?
- What are the implications for policy-making?

The foresight exercise **builds on and complements** the results of preceding and parallel analyses presented in the European Cluster Trends Report, which are mainly based on (quantitative) data analysis[2]. The foresight analysis

- makes use of the global mega trends affecting societal and industrial transformations and discusses additional trends impacting on the wider environment in which clusters operate;
- relates to the Emerging Industries e.g. in the roadmaps developed during an expert workshop and in the scenarios of future clustering presented and discussed in this report;
- addresses the internationalisation of clusters and stresses the importance of the regional dimension.

In addition to the aforementioned quantitative analyses, the foresight exercise provides a qualitative approach, draws on other sources and makes use of another set of methods to explore factors that will shape the future of cross-clustering and industrial transformation.

Analytically, the foresight exercise approached the question of industrial transformation and cross-sectoral linkages from the **vantage point of clusters**. Clusters are “geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (...) in particular fields that compete but also cooperate”[3]. Today clusters are increasingly managed by specialised institutions: cluster initiatives.[4] A cluster initiative can be regarded

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[1] *See http://www.foresight-platform.eu/community/forlearn/what-is-foresight/*

[2] *European Cluster Trends, Preliminary Report, European Commission, Brussels 2014*

[3] *Porter, M. E., On Competition, Harvard Business Press, Boston MA 1998, p. 78*

[4] *European Commission, The concept of clusters and cluster policies and their role for competitiveness and innovation, Commission Staff Working Document SIC (2008) 2637.*

as an organised effort of a network of cluster actors to increase the growth and competitiveness of a cluster. It usually avails itself of a coordinator and, possibly, a number of support functions – the cluster (management) organisation.[5]

- Clusters "are **cross-sectoral** by their nature, as they refer to a concentration of related industries and institutions, and thus, they can be platforms for innovation and industrial change (…) [T]hey transform and reinvent themselves in response to changes in the external environment or changes initiated within the cluster, which can be amplified through positive feedback between this external environment and the cluster itself".[6]
- **Cross-clustering** means the strategic cooperation of two or more clusters in the same industry or across different sectors. In face of increased competitive pressure industry seeks ways to create new value chains. Clusters and networks can be considered as "springboards" for enabling collaboration among companies and research institutions within the same region, the same country or in different countries. In other words, the geographical dimension of cross-clustering can be regional, national, European or international.[7]

The foresight exercise addressed not only the trends and future developments in the external business environment but in particular in the social, technological, economic, ecological, and value (STEEPV) dimensions of the environment of clusters.[8]

To this end the foresight team[9] identified trends and factors that drive cluster development with a double focus on the trends of industrial transformation and on trends that have their origin in contexts other than clusters. It developed inductive exploratory scenarios of alternative futures of clustering in Europe and outlined consequences for industrial structures and delineated policy implications. The team used the foresight process to stimulate dialogue and promote stronger networking between cluster practitioners across Europe.

The report is **structured** as follows:

- Section 1 is the Introduction to the report;
- Section 2 details the methodological approach;
- Section 3 provides the results of the analysis from the different data streams;
- Section 4 explores the future of clustering and
- Section 5 outlines the conclusions and recommendations.

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[5] *Sölvell,O., Lindqvist, G., Ketels, C., The Cluster Initiative Greenbook. Ivory Tower AB, Gothenburg 2003. It is assumed for the purpose of this study that cluster initiatives have a cluster organisation. Hence, the two terms are used here synonymously.*

[6] *European Cluster Trends, Preliminary Report, European Commission, Brussels 2014, p. 12*

[7] *Lämmer-Gamp, Meier zu Köcker, Nerger, Cluster Collaboration and Business Support Tools to Facilitate Entrepreneurship, Cross-sectoral Collaboration and Growth, 2014 (electronic version: http://ec.europa.eu/enterprise/initiatives/cluster/observatory/2014-10-10-eco-report-d4.1.pdf)*

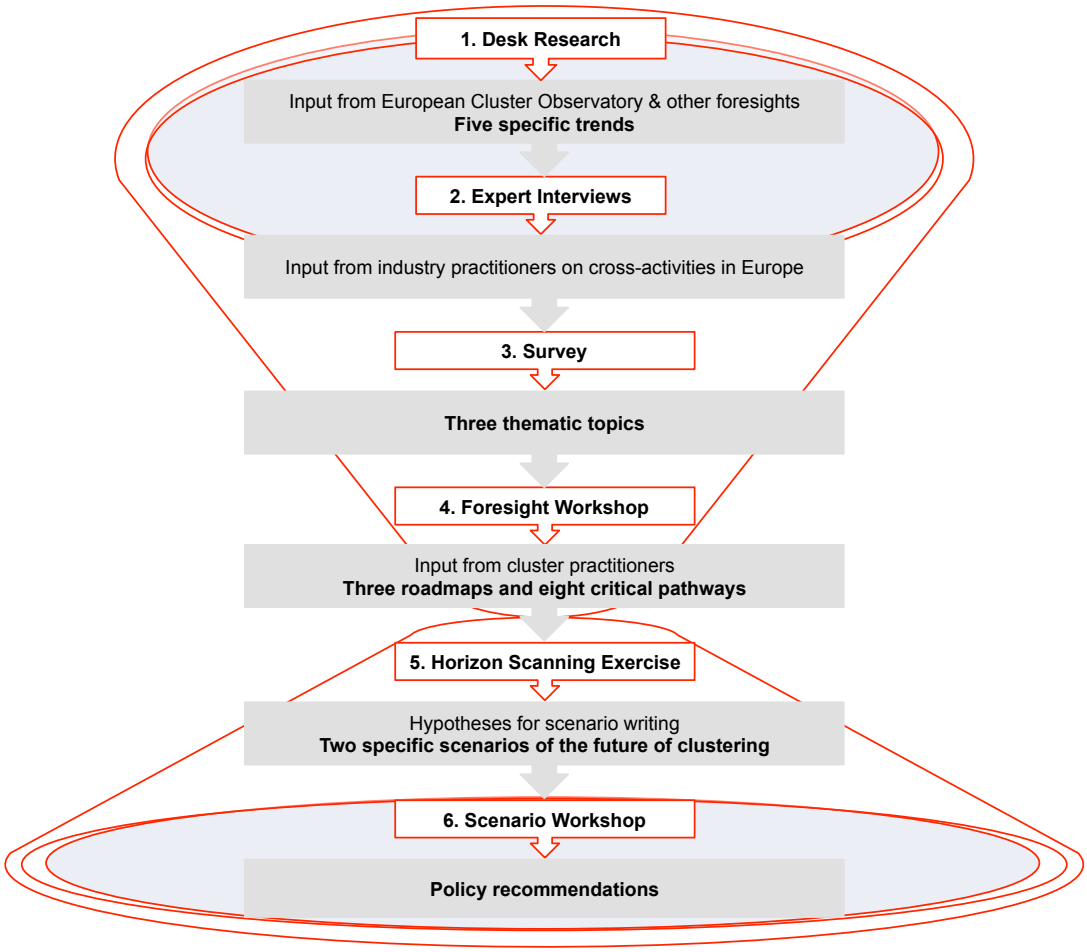
[8] *European Foundation for the Improvement of Living and Working Conditions, 2003 (electronic version: http://www.uni-mannheim.de/edz/pdf/ef/03/ef0350en.pdf)*

[9] *The foresight team consisted of the authors of this report. Their expertise was complemented by that of other experts from Technopolis Group and VDI/VDE-IT.*

2. Foresight methodology

In line with the Methodological Report[10] the team followed a **Delphi-related approach and used a mix of different methods** commonly applied in foresight exercises to gather and analyse data and to formulate conclusions and recommendations for policy-makers. The Delphi-related approach is a consultation process that involves a wide group of participants, in a process that applies a set of predefined questions[11]. In this process the following six methods were used: desk research including a literature review, expert interviews, online-survey, internal and external workshops, horizon scanning and scenario planning. These methods were combined in a sequential way so that the output of one step presented the foundation for the next step. The combination of different methods allowed to triangulate the results. The following figure illustrates the way the methods were combined, as well as the product of each analytical step.

Figure 1: Steps of the Foresight Exercise



Source: Technopolis Group and VDI/VDE-IT

The two funnels in the figure above, show that the foresight team first gathered a wealth of data from a variety of sources (desk research, input from other work packages, interviews, workshops), which

[10] *See European Cluster Trends - Methodological Report, European Commission, Brussels, 2014, ch. 4*

[11] HM Government, The Futures Toolkit. Tools for strategic futures policy-makers and analysts. London 2012

were analysed and, in the following steps (survey and foresight workshops), refined and condensed, leading to a first sketch of the future of clustering in the form of three roadmaps. Subsequently, the funnel was opened again, as the team sought additional input in a horizon scanning exercise to then build rich scenarios about the future of clustering and to formulate policy recommendations. Each of these steps will be briefly described in the following paragraphs, while the reader is referred to the Methodological Report for a more extensive discussion of the methodology.

1. The foresight exercise started with a comprehensive **desk research** and a harvest of the existing results of the European Cluster Observatory and other foresight exercises. In particular the team build on the global mega trends, the discussion of Emerging Industries and the dimensions of collaboration spanning through emerging industries identified in the European Cluster Trends Report[12] to thematically structure the work. The results were collated in an initial desk research and conversations within the entire project team. The desk research also covered the output of other foresight exercises such as the reports of the UK Government Office for Science[13], that of the German Ministry of Research and Education (BMBF)[14]. As a result the foresight team arrived at a set of general issues and five specific trends that were deemed of particular importance for the future of cross-cluster development.

2. In line with the approach set out in the Methodological Report, which built on the Delphi methods and involves the consultation of a variety of experts, the team conducted a **set of interviews** with representatives from European industry associations about cross-sectoral and cross-cluster developments.[15] The goal was to broaden and enrich the results of the first step with an empirical perspective and to receive a feedback on the relevance of cross-clustering from the view of industry experts. In particular, respondents were asked about their opinion with regard to key technological developments and their impact on European clusters; the central characteristics of the evolving policy settings, as well as principal changes they expect for clusters and cluster organisations.

3. Based on the desk research and the interviews, a questionnaire for a **survey among cluster managers** was developed to gather information about the "practical framework" of cross-sectoral activities in Europe. In November 2014 the project team conducted a survey among managers of excellence clusters from across Europe, representing 120 of the most active and well-established cluster initiatives that were benchmarked by the European Secretariat for Cluster Analysis (ESCA). All in all the team received 42 responses. Although this number is too small to allow for statistically valid inferences, the answers nevertheless provide empirical evidence for important conclusions.

   Based on the expert interviews, the results of the survey amongst cluster managers and output from other work strands of the European Cluster Observatory the team narrowed the five specific trends down and selected **three thematic topics** for further discussion: Smart Everything, Personalisation of Products and Services, and Resource Efficiency. Two of them (Smart Everything and Resource Efficiency) were considered to be the most important drivers of

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[12] See in particular European Cluster Trends, Preliminary Report, European Commission, Brussels 2014, ch. 1-4

[13] See https://www.gov.uk/government/collections/foresight-projects#foresight-reports

[14] See http://www.bmbf.de/en/18378.php The reports on societal challenges, trends, research and technology perspectives are available in German only and can be accessed through http://www.bmbf.de/de/foresight.php

[15] The interviews were conducted with representatives from the European Chemical Regions Network (ECRN), European Technology Platform Food for Life, Europabio – The European Association for Bio-Industries, European Creative Industries Alliance, and the European Factories for the Future Research Association (EFFRA).

cross-clustering opportunities by the survey respondents. The third trend – Personalisation of products and services – was selected, as some respondents in the open question part of the survey brought it up. In addition this trend was also identified by the analysis in other parts of the project[16]. Finally, the choice of the three trends provided a balanced consideration of supply- and demand-side aspects: Resource-efficiency emphasises a production-oriented view, Smart Everything espouses a combination of supply-and demand-driven characteristics and the Personalisation-trend accounts for aspects that might drive cluster development from the demand-perspective.

4. An internal workshop held back to back to a **foresight workshop** with external experts explored the three themes in greater depth. The expert foresight workshop, conducted in January 2015 in Berlin, brought together 23 cluster practitioners from 15 European countries. The experts developed three rich and society oriented roadmaps including eight pathways, thereby providing a multifaceted information basis for the scenario writing process. The three themes were taken to structure the discussion at the workshop and to allow the participants to exchange their views on drivers and impacts these trends might have on cluster development.

5. In the subsequent qualitative **horizon scanning**, evidence for already existing cross-cluster relations and mechanisms was searched complementing the expert interviews, the cluster manager survey and the expert workshop outcomes. It was based on qualitative text analysis related to the principle of the grounded theory known from social sciences with the aim to identify thematic convergence, as well as information about examples for cross-sector and cross-cluster developments, their key factors and framework conditions.

6. Finally, the foresight team used the **scenarios** to explore the future of clustering in Europe 2025. A **scenario** is a 'story' illustrating visions of a possible future; it combines know facts with trends and key drivers and has relevance for the question under investigation.[17] Its analysis enables users to gain a better understanding of driving forces and the ways in which they may interact, and thus be able to make better informed choices in the present and to be better able to apprehend and comprehend future developments as they unfold.

   Starting from a baseline scenario the team drafted **two specific scenarios with a timeframe** of five to ten years, i.e. the scenarios present a world in the year 2025. Such a timeframe has proven useful in many scenario exercises for several reasons: First, the time frame is of appropriate length to formulate policy recommendations, to implement (some of) them and to evaluate them. Second, this time frame allows accounting for the usual gap between the final development stages of a technology and its application. Finally, the chosen time frame has proven in other foresight exercises to be psychologically short enough to imagine alternative futures and long enough to not envision the future as a simple continuation of the present.

   The scenarios were discussed and elaborated during a scenario **workshop** held in May 2015 in Berlin. These inductive, bottom-up scenarios explore to what extent cross-sector and cross-cluster phenomena could become increasingly important for the economic development of regions and entire innovation systems. The team examined the two specific scenarios for overlaps providing important linkages and pointing to tensions in future development.

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[16] *See for example European Cluster Trends, Preliminary Report, European Commission, Brussels 2014, Chapter 1, as well as the forthcoming case study "Framework conditions to support emerging industries in the area of healthcare – From treatment to prevention and wealth". European Commission, Brussels, forthcoming*

[17] *See http://www.foresight-platform.eu/community/forlearn/how-to-do-foresight/methods/scenario/*

Based on the refined scenarios, as well as the other results of the foresight exercise the team drew conclusions and formulated **policy recommendations** in an iterative internal discussion process.

While every foresight exercises is qualitative in character, contains an element of judgement and was in this case conceived from the beginning as a complementary element to the quantitative analysis of other work packages of the European Cluster observatory, the foresight team employed several strategies to make sure that the results are not biased to the views of a particular group. First, a mix of different methods was used to gather and analyse data. Moreover, the literature review included a wide range of textual sources from blogs, websites, to newspaper articles and reports. The team compared and triangulated the results of the analysis from different sources and, finally, involved experts from different stakeholder groups throughout the process.

3. Results and analysis

3.1 Desk research

The foresight exercise started with a **comprehensive desk research**, for which a variety of foresight reports, as well as the results of previous work under the European Cluster Observatory were consulted.

The output of the European Cluster Trends Report and the Summary Report on Cluster Internationalisation and Global Mega Trends[18], as well as the Cluster Collaboration and Business Support Tools to Facilitate Entrepreneurship, Cross-sectoral Collaboration and Growth[19] were other important sources for the desk research. The foresight team drew in particular on the work done with regard to the global mega trends, the discussion of emerging industries and the dimensions of collaboration spanning through emerging industries.

In addition, the desk research examined the results of **other foresight exercises** such as the reports of the European Strategy and Policy Analysis System (ESPAS), the German Ministry of Research and Education (BMBF) or the UK Horizon Scanning Centre. The goal was to identify trends and important factors in the wider context, for example in society, culture, politics, that could be of importance for the future of cross-secotral and cross-cluster developments.

The desk research for the foresight exercise yielded **three main results**:

First, the foresight team could not identify any foresight reports addressing specifically the future of cross-sectoral developments or cross-clustering. The desk research was conducted in the commonly known databases.[20] While a number of articles have been published on the topic of cross-clustering, it appears that no dedicated foresight exercise has been conducted on the topic so far.

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[18] Summary Report on Cluster Internationalisation and Global Mega Trends, European Commission, Brussels 2014

[19] Cluster Collaboration and Business Support Tools to Facilitate Entrepreneurship, Cross-sectoral Collaboration and Growth, European Commission, Brussels 2014

[20] The search was conducted in the usual databases accessible through the internet, such as Google Scholar and complemented by a general web search.

Second, there are a number of foresight reports on specific technologies, sectors as well as overarching trends affecting industrial transformations.[21] These are relevant for clustering as they indicate possible industrial trends and as a consequence cluster development dynamics. The European Cluster Trends Report 2014 summarizes several technology and sectoral foresights and condenses them into 12 "mega trends affecting industrial transformations".[22] As mentioned in the European Cluster Trends Report, "mega trends can be seen as the fundamental **catalysts for growth in markets** as they influence several determining factors, such as consumer behaviour and business processes. Consequently, they may provide major support and a strong foundation for the introduction of new products and services. Additionally, mega trends may also unlock latent demand and revitalise growth in existing, mature markets by influencing price, performance, availability and quality improvements."[23]

Third, for the purpose of the foresight exercise these "mega trends affecting industrial transformations" have to be distinguished from general or **wider mega trends**, which concern more general, political, economic/industrial or societal trends that will shape the wider environment in which clusters operate. The standard point of reference for a discussion of wider trends is the publication on mega trends by John Naisbitt from 1982 and its more recent "updates".[24]

- According to European Environment Agency mega trends are "those trends visible today that are expected to extend over decades, changing slowly and exerting considerable force that will influence a wide array of areas, including social, technological, economic, environmental and political dimensions."[25]
- The mega trend updates concern, on the one hand, demographic change and climate change were not explicitly included in the original mega trends. Their "game changing" character has only been captured under a trend "From short-term to long-term". On the other hand, the original mega trends remain somehow abstract and do not refer to recent developments and economic, technological and societal settings. For this reason, megatrend updates – or better still "specifications" – are helpful means that specify otherwise abstract developments.

The following **table relates the two sets of trends**, that is the set of original mega trends as identified by Naisbitt and the industrial mega trend set, identified by early work of the European Cluster Obser-

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[21] *See for example VDI TZ, Fraunhofer ISI, BMBF-Foresight-Zyklus II Suchphase 2012-2014, Zwischenergebnis 3 – Forschung- und Technologieperspektiven 2030, 2014 (electronic version: www.bmbf.de/pubRD/BMBF_140818_bericht_3_forschungs_technologieperspektiven_2030_barrierefrei.pdf); Government Office for Science, Technology and Innovation Futures: UK Growth Opportunities fort he 2020s – 2012 Refresh, 2012 (electronic version: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/288562/12-1157-technology-innovation-futures-uk-growth-opportunities-2012-refresh.pdf); Boden, M. et al, Facing the future: time fort he EU to meet global challenges. JRC; Scientific and Technical Reports, 2010 (electronic version: http://ftp.jrc.es/EURdoc/JRC55981.pdf); European Commission, Preparing the Commission for future opportunities – Foresight network fiches 2030, Working Document, 2014 (electronic version: http://ec.europa.eu/digital-agenda/en/news/looking-future-digital-technologies)*

[22] *European Cluster Trends, Preliminary Report, European Commission, Brussels 2014, ch. 1*

[23] *European Cluster Trends, Preliminary Report, European Commission, Brussels 2014, p. 4*

[24] *See Naisbitt, Megatrends – Ten New Directions Transforming Our Lives, Warner Books, New York 1982 and Z_punkt GmbH – The Foresight Company. Megatrends Update, 2012 (electronic version: http://www.z-punkt.de/uploads/files/234/z_punkt_megatrends_de.pdf) respectively.*

[25] *Velkavrh, Global Megatrends Assessment. State of Environment and Outlook Report 2010, Swedish Environmental Objectives seminar, 2012 (electronic version: http://projektwebbar.lansstyrelsen.se/rus/SiteCollectionDocuments/Seminarier%20och%20konferenser/Milj%C3%B6m%C3%A5lsdagarna/Borgholm%202012/MMD12-dok07-global-megatrends.pdf)*

vatory[26]. Due to the fact that both sets represent two distinctive levels of transformation processes, the mega trend update from 2012 in the middle column has been used to connect both trend-sets. The table is not to show a exact resemblances of the different trend sets but rather demonstrate correspondences and analogies.

Table 1 Relating mega trend sets from different sources

Original Mega trends (1982)	Mega trends Update (2012)	Industrial Mega trends (2015)
From Short Term to Long Term	Demographic Change	
From Institutional Help to Self-Help	New Levels of Individualisation	Impact of Social Media Personalisation of products & services
From Either/Or to Multiple Option	Social and Cultural Disparities	
From Institutional Help to Self-Help	Reorganisation of Healthcare Systems	Personalisation of products & services Consumerisation, proliferation, ubiquity of IT
From Either/Or to Multiple Options	Changes to Gender Roles	
From Centralisation to Decentralisation	New Patterns of Mobility	Immediate availability of products & services
From Representative Democracy to Participatory Democracy	Digital Culture	Impact of social media
From Forced Technology to High Tech/High Touch	Learning from Nature	Carbon foot-print reduction
From Industrial Society to Information Society	Ubiquitous Intelligence	Cross-linkage of subjects & objects; Big data; Consumerisation, proliferation, ubiquity of IT
From Forced Technology to High Tech/High Touch	Technology Convergence	Convergence of products, device and services
From National Economy to World Economy	Globalisation 2.0	Changes of geo-economical dynamics
From Industrial Society to Information Society	Knowledge-based Economy	Shortening of product lifetime cycles
From Hierarchies to Networking	Business Ecosystems	Changes in entrepreneurship culture
From Hierarchies to Networking	Changes in the World of Work	Innovation dynamics
From Either/Or to Multiple Options	New Consumption Patterns	Personalisation of products & services Immediate availability of products and services
From Short Term to Long Term	Upheavals in Energy and Resources	Consumerisation, proliferation, ubiquity of IT
From Short Term to Long Term	Climate Change and Environmental Impacts	Carbon foot-print reduction
From Centralisation to Decentralisation	Urbanisation	Consumerisation, proliferation, ubiquity of IT
From North to South	New Political World	Innovation dynamics

[26] *European Cluster Trends, Preliminary Report, European Commission, Brussels 2014, ch. 1*

Original Mega trends (1982)	Mega trends Update (2012)	Industrial Mega trends (2015)
	Order	
From North to South	Global Risk Society	

The foresight team related the mega trend sets from different sources on the basis of the more detailed accounts of each trend. The links are often not merely based on one but rather multiple relationships. The result of the analysis shows that, no matter what the source of the trend is, there are corresponding trends, which are highly compatible with and can be related to other, more specific trend sets.[27]

In view of the particular topic examined in the foresight exercise the foresight team distilled the three sets of trends further. The **five specific trends** presented below account for factors in the closer context of industrial transformations and cross-cluster developments and were deemed to be of particular importance for the future development:

- Digitalisation and related topics such as big data, Internet of Things, ubiquitous sensors etc. ("Smart Everything")
- Natural resource scarcities, climate change, carbon footprint and environmental concerns ("Resource Efficiency")
- Convergence of technologies, e.g. convergence of information, nano- and biotechnology for instance for medical implants of molecular bionic ("Converging Technologies")
- Regionalisation of political concerns, participatory democracy, consumption patterns and value chains ("Regionalisation of value chains")
- Working in a smart and digitalised world ("Work 4.0")

These five trends were corroborated and substantiated in expert interviews and in a survey held among cluster managers.

3.2 Expert interviews

Following the Delphi-related approach, which requires the consultation of a variety of experts, the foresight team interviewed a wide range of specialists, including those that are not particularly close to the issue of clustering and cluster policy. In fall 2014, the team conducted five expert interviews with **representatives from European industry associations** and organisations. In this way the team captured opinions on the future of cross-sectoral collaboration from industry experts who are not specifically involved in cluster related activities. Nevertheless, most of the representatives interviewed, have been dealing with questions of relevance for cross-clustering and industrial change like cooperation and – to a lesser extent – open innovation. The aim of the interviews was to broaden and enrich the results of the first step with a sector focused i.e. an industry perspective.

In general, representatives of industry associations had little familiarity with this phenomenon of **clustering**. It should be noted that interviewees took clusters as a synonym for any kind of association and not as a particular policy instrument. The overall impression among them was that cross-sector and

[27] For a more detailed discussion of an exemplary foresight study see Appendix A: Trends identified by ESPAS.

cross-cluster activities have not played an important role for their business and their industry associations so far. Finally, cross-clustering was also not considered as something that will be of importance in the future.

Despite their unfamiliarity with the instrument of clusters, the interviewed experts pointed to the **importance of regional dimension** for industrial development. In some cases such as food production the trend towards an increased demand for regional products is a broad societal phenomenon; one that exists side to side to the globalised and industrialised mass production. At the same time, it seems that other sectors such as the chemical industry are still discovering the "added value" of a more regional focus of their value creation.

To the extent that **cross-sector collaboration** was considered to be important to their industry, the interviewees saw new technologies as the main drivers for collaboration across different sectors. The main effects were supposed to result from the broad implementation of ICT and the on-going digitisation. When everything is transferred to and represented in a binary world of "0" and "1", frontiers of sectors become merely frontiers of different data spaces. Consequently, the experts emphasised the important role of Big Data and Cloud Computing for future industrial development, even if the majority of the related visions (business models etc.) still remain somehow vague. It became evident that the "new" resource – data – should (partly) be used to decrease the usage of "old" resources like energy, water, land, air, materials across the entire lifecycle in what has been called cradle to cradle approaches.[28]

Even in light of the rather modest views on cross-sector and cross-cluster effects, the interviewees highlighted the different roles of big and small companies for future innovation. In this context, the following excerpt of an expert interview[29] with a representative of an association for biotechnology and bio-economy provides a view on the dynamic development of possible emerging industries:

Question: If you think of cross-cluster and cross-sector development, what examples can you give?

Answer: The biotech-sector is *per se* and due to its origin strongly cluster-based. A high importance has to be paid to start-ups as key innovation drivers that grow in collaborative high-tech contexts (campus-settings and comparable) and that nearly always include other (platform) technologies, have a strong link to ICT (data processing etc.) and to applying sectors like agriculture. As biotech is a crosscutting technology and "enabler", it often reveals its innovative power by pushing "traditional" industries forward (e.g. Pharma).

Question: Which factors and developments are currently driving cross-cluster and cross-sector development in Europe?

Answer: Big companies are structured in departments and therefore tend to lack internal cooperation. Here, clusters might compensate the missing collaboration "culture" *via* external impulses and exchange. At the same time, SMEs and especially start-ups are still the real innovation drivers. A comparably new tendency is that successful SMEs are nowadays not necessarily bought straight away by "Big Industry", but are kept in the collaborative ecosystem (access as well for competitors).

Another factor is the increasing importance of being able to integrate new technological developments and various technologies at the same time; this requires a general openness that facilitates as well cross-sector collaboration.

[28] McDonough, W., Braungart, M., Cradle to Cradle: Remaking the Way We Make Things, Durabook, New York 2002

[29] Interview conducted on 11 September 2014 by telephone and approved by E-Mail on the 21st of October 2014

In pharma, there can be observed a strong change in paradigm: The personalised or – at least – stratified medicine is "the next big thing" that impacts the pharma industry as a game changer: new business models must be set up that are located between the extreme poles "Blockbuster" and "Orphan Drug".

These comments allow to draw two important conclusions: On the one hand, they are further evidence for the importance of the three cross-sectoral **collaboration spaces of related industries**, discussed in the European Cluster Observatory (computer and peripherals; healthcare industries and environmental industries).[30]

On the other hand, the comments point to the **role of start-ups** as highly relevant in the broader context of industrial development. Start-ups and their capability to develop game changing technologies etc. represent the ability to broaden the scope of procedures, products and services normally within an industry.

While this idea about the role of start-ups cannot be generalised, taking start-ups as a **metaphor for new input in established sectors and industries** helps to get a deeper understanding of cross-cluster and cross-sector collaboration: cross-cutting activities have a similar effect e.g. by leading to the integration of new methods (e.g. new ways of conceptualising issues, defining products, services and thereby redrawing the boundaries of markets; novel ways of thinking and problem-solving). Such an impetus can shape the diversification within sectors/clusters and contribute to the ability of companies to address and drive industrial complexity.

3.3 Survey

Based on the central results of the interviews and the document analysis the team conducted a survey among cluster managers. The survey yielded a number of interesting results regarding the future of cross-collaboration between clusters and sectors. Five key findings are briefly outlined below.

First, a clear majority (83 %) of managers of excellence clusters[31] from across Europe was aware of examples of cross-clustering[32] and 90 % of them thought that cross-clustering is important for future cluster development[33]. Compared to the evidence gathered by the expert interviews among industry experts the **awareness about cross-clustering** appears to differ between experts working for industry associations and those working for cluster organisations. While the interlocutors from industry associations were hardly aware of these types of cross-collaboration (see the discussion in Section 3.2), the situation was entirely different for cluster managers.

Second, the **concrete examples for cross-clustering**, which cluster managers pointed to, concern the same areas identified above by the analysis of industry data – the three collaboration spaces: internet/ICT services, eHealth and eco-innovation. The majority of cluster managers pointed out that networking and participation in trade fairs as examples of cross-clustering activities. It is mainly information exchange and networking rather than more far-reaching forms of collaboration along the value chain (e.g. research, production or marketing) that have so far characterised cross-clustering.

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[30] For further information see European Cluster Trends, Preliminary Report, European Commission, Brussels 2014, ch. 4

[31] For a detailed breakdown of the survey participants see Appendix B: Survey among cluster managers

[32] For details see Appendix B: Survey among cluster managers, 2. Awareness of cross-clustering.

[33] For details see Appendix B: Survey among cluster managers, 3. Significance of cross-clustering.

Third, about 80 % of the respondents stated that their cluster initiatives **pursue a cross-clustering strategy**, The survey results imply, that there is a difference between sectors in the extent to which cross-clustering is pursued as a strategy. For example, biotechnology, production & engineering, and health & wellbeing are three sectors in which cross-clustering is very pronounced; while this strategy is comparatively less accentuated in the new materials, renewable resources, construction and energy sectors.[34]

Fourth and related to the last above, clusters that pursue a cross-sectoral clustering strategy can do so with partners at regional, national, EU or international level – what is referred to as the 'geographical reach/orientation' of the cross-clustering strategy. The survey results imply that the **geographical orientation** of cross-clustering strategies varies across Europe.

- In Western Europe all four geographical orientations are present, i.e. there is an almost equal number of clusters that collaborate with partners at regional, national, EU or international level respectively.
- In Northern and Southern Europe the EU-dimension clearly dominates the cross-sectoral strategies of cluster organisations, i.e. they mostly team up with partners in other EU countries.
- In Central Europe the regional dimension represents the most frequent geographic orientation of cross-clustering strategies.[35]

Finally, cluster managers were asked to prioritize the drivers for cross-clustering opportunities. The list put to respondents was drawn up on the basis of the desk research conducted for the foresight exercise in an internal discussion by the foresight team (see Section 3.1. Starting from an analysis of a variety of foresight reports and drawing on the global mega trends shaping emerging industries the foresight team had identified the following five trends for cluster-opportunities:[36] "Smart Everything" and "Resource Efficiency" to be the most important trends, followed by "Converging Technologies", "Regionalisation of Value Chains" and "Work 4.0". In addition to prioritising a number of listed trends, cluster managers themselves pointed to a number of additional drivers, chief among them the personalisation of products and services.

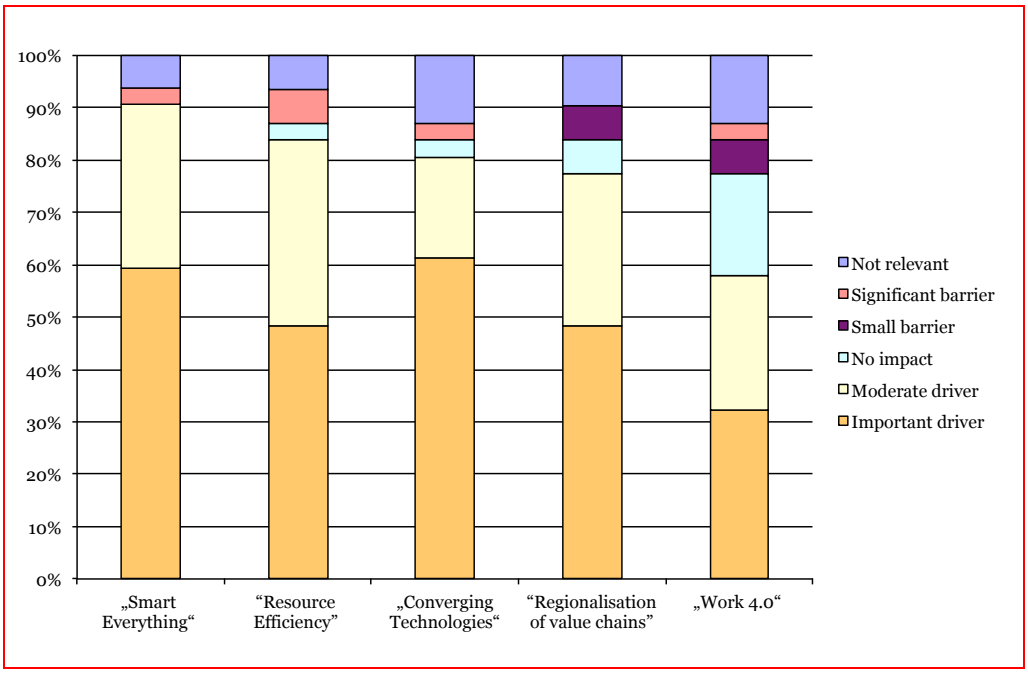
When cluster managers were asked to prioritise these **five specific trends**, which might have an impact on cross-clustering in Europe, they gave the answers illustrated in the following figure.

[34] *For details see Appendix B: Survey among cluster managers, 4. On cross-clustering strategies.*

[35] *There were no responses from clusters surveyed from Eastern Europe. For further details see Appendix B: Survey among cluster managers, 5. Geographic dimension of the cross-clustering strategy.*

[36] *See the results of the desk research in Section 3.1.*

Figure 2: Importance of each of the five trends for cross-clustering opportunities (n=32)



Source: European Cluster Observatory; survey conducted by Technopolis and VDI/VDE-IT

Most cluster managers consider “Smart Everything” and “Resource Efficiency” to be the most important trends, followed by “Converging Technologies”, “Regionalisation of Value Chains” and “Work 4.0”. In addition to prioritising a number of listed trends, cluster managers themselves pointed to a number of additional drivers, chief among them the personalisation of products and services.

The project team decided to focus the subsequent analysis on three trends and to have them further discussed in the expert foresight workshop.

3.4 Outcome of the expert foresight workshop

The goal of the foresight workshop was to define the most promising and dynamic areas of industrial transformation and cluster-development, collaboration patterns and value creation. During the workshop, three expert groups (23 cluster experts from 15 European countries) developed roadmaps covering the three thematic areas:

1. The trend **Smart Everything** describes a comprehensive digitalisation of all spheres of life, such as the convergence of technologies driven by smart home, internet of things, or e-mobility. Especially sensors, software and hardware required to generate, transfer and process vast amounts of data, are becoming smaller and more powerful every day. Users are moving through a connected world and with the evolution of mobile technology not only single devices but all objects are becoming smart.

   Smart Everything covers a wide range different areas: smart grids (energy), smart home (personal space/environment), smart mobility (intermodal mobility based on individualised real time information combining existing opportunities and personal preferences), smart cities (cross between energy, living, mobility, consumption, security, local affairs), smart factories (the 4th industrial revolution triggered by cyber-physical systems) and smart farming (precision framing, harvesting by plant specific ripening monitoring, resource and energy efficiency).

Even if parts of these developments are already well known and at least partially applied, a growing number of former "smart islands" interconnect and allow new ways to use, to control and to integrate the (manmade) environment. As Mark Weiser's 1991 vison of "Everything, always, everywhere" becomes reality today, it will have a tremendous impact of how we live learn and work. Especially existing labour settings and value creation will be strongly affected. Maybe it will not be that much the question "what" will be produced, but "how" it will be made. Described as such, this trend combines both an industry-oriented and a consumer-oriented perspective.

2. **Resource Efficiency** concerns production and consumption patterns with an emphasis on reduced use of natural resources and thereby reduced environmental impacts and cost. As natural resources will be no longer abundantly available and in face of the limited absorption capacity of the natural eco-system, both production and distribution need to become more efficient. Reuse of materials, relocating value creation and transforming manufacturing are key aspects towards a more efficient use of resources. More recent concepts like the cradle-to-cradle approach or circle economy are going even one step beyond. Instead of limiting for example carbon footprint, the cradle-to-cradle concept sees carbon as a potential resource that "only" has to be managed/used in a constructive and productive way.

   Resource efficiency and related innovations are key drivers to reduce production costs in a globalised world. Due to high automation levels, labour costs make a comparable small share in many industries, whereas the costs for resources (material) are constantly growing. Efficiency pioneers are thought to be better off in competitive settings than companies without adequate means to lower their consumption.

3. **Personalisation of Products and Services** coincides with self-realisation and individualisation that are apparent, observable factors in modern societies. Together with fragmented, dynamic target groups, market segments are no longer easily distinguishable. A growing demand for personalised products and services essentially boils down to a "market segment of one". This requires flexible production/service-offers and the ability to recognise individual demand. This shift in consumption behaviour is not only driven by changing values but also by technological innovation. Shortened product lifecycles, faster and more flexible manufacturing processes (e.g. 3D printing) and open innovation systems allow for a mass customisation of personalized products.

   Consumption of material goods alone is no longer a distinguishing characteristic of success and wealth. Individual services provide additional value for consumers in order to differentiate themselves from others. Online platforms like Airbnb (shared housing) or Uber (mobility) provide offers for people looking for individual experiences. As part of the 'sharing economy', these platforms provide the ability to link individual supply and demand, allowing for exchange of personalized products and services.

These three trends were used to structure the discussion at the workshop and to allow the participants to exchange their views on drivers and impacts these trends might have on cluster development. They provided the thematic range of the discussion and the framework for the realisation of three roadmaps illustrating possible paths and cause-and-effect-relations in future cluster development. The activities during the workshop led to the preparation of three roadmaps.

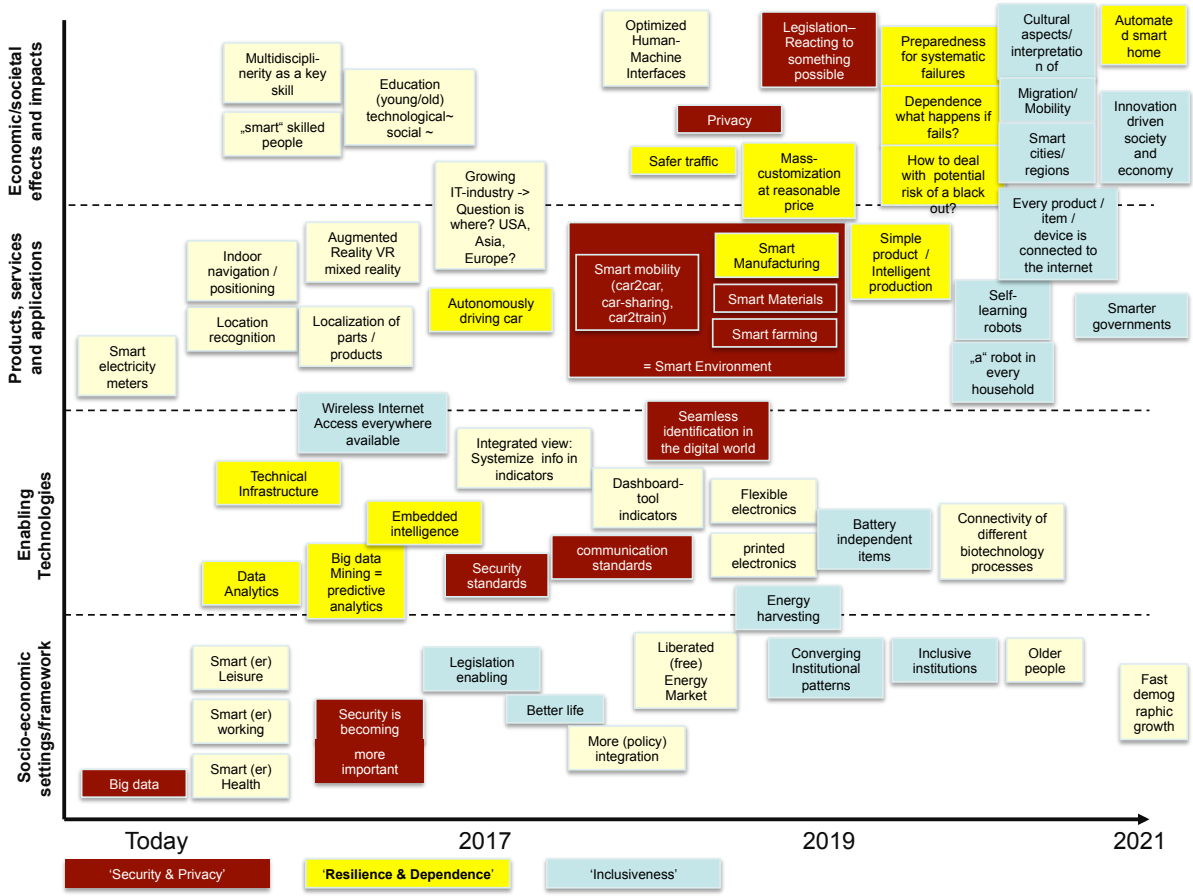
Roadmap 'Smart Everything'

Smart Everything – as described in the previous Section – influences all spheres of life, as smart technologies converge. Examples range from energy (smart grids), mobility (autonomously driving cars, intermodal mobility), production (4th industrial revolution) as well as agriculture and personal living

(smart homes). Within the trend of 'Smart Everything' three pathways were identified during the workshop.

1. The first pathway '**Security and Privacy**' (highlighted in dark red) is placed in a specific socio-economic context containing aspects such as big data and concerns about security. Technological developments along this pathway concern standards for data and information security, as well as communication. A seamless identification in the digital world is identified as a key aspect when people are moving through smart environments. These developments might in turn change the value of privacy both on an individual level, as well as a societal level and influence legislation to react to new requirements regarding the protection of privacy. Essentially the pathway can be viewed as a feedback loop, where new legislative decisions result from technological developments. In turn, these legislative changes facilitate changes within the socio-economic setting. Changed socio-economic circumstances might lead to new technological developments that again influence legislative actions.
2. The second pathway '**Inclusiveness**' (highlighted in pale blue) focuses on the rules and regulations that influence the socio-economic framework e.g. national laws, standards, values and norms and thus the understanding of inclusiveness. The main questions influencing developments along this path concern whether or not 'Smart Everything' should or could include anybody and if so, how this goal can be achieved. Specific enabling technologies include access to wireless internet anywhere, the necessary energy to operate all kinds of connected objects and devices and predictive data analytics. The development of these technologies might lead to a future where every household has at least one robot with environments where every object is connected to the internet. These enclosed environments make up smart cities and finally smart regions, where mobility, logistics and work settings are all connected. In answering the question whether or not these technology-driven developments should include everyone, one has to consider cultural aspects that influence the interpretation of what 'smart everything' actually means in an innovation driven society and economy.
3. The third pathway '**Resilience and Dependence**' (highlighted in bright yellow) concerns the vulnerability and interdependence within and between connected systems. The pathway is again based in very specific socio-economic framework, where security concerns are an important issue. This can mean both individual security as well as societal security. Security can be guaranteed by creating a technical infrastructure that addresses potential threats. Within this infrastructure, intelligent systems measure and evaluate warning signs and automate appropriate responses. One example would be the recent developments regarding autonomously or self-driving cars as a step stone towards smart mobility solutions. Separated but not unrelated other intelligent systems might include smart assembly lines and materials enabling smart manufacturing. Within and among these systems, the risks of failure can be technologically addressed only if the conditions are set either at legislative level or at societal level through norms and agreed guidelines. Through a feedback loop these new regulations and norms change the socio-economic framework over time and influence the realization of improvements to the technical infrastructure.

Figure 3: Roadmap 'Smart Everything' with three pathways



Source: European Cluster Observatory, prepared by VDI/VDE-IT and Technopolis Group

Roadmap 'Resource Efficiency'

Experts understood resource efficiency in a rather broad way. In their view, it encompasses not only energy and material but also process efficiency.[37] The resulting roadmap in this thematic is coined by three central pathways.

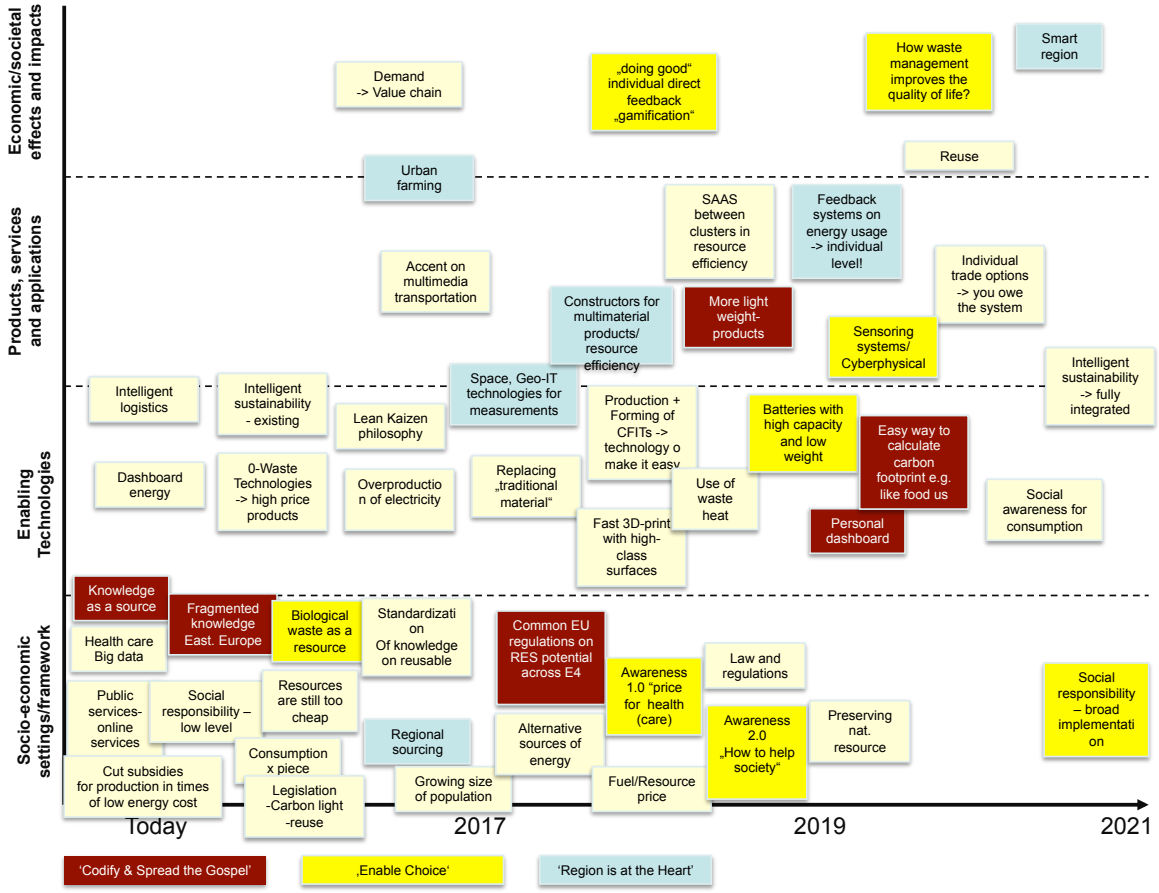
- The first pathway '**Codify & Spread the Gospel**' (path marked in dark red) takes its starting point from a socio-economic context that can be characterised by a fragmentation of knowledge about resource efficiency. There are considerable gaps between the knowledge about fostering a resource efficient way of production and living of people living in different regions in Europe. The gaps concern expertise at individual level, e.g. what is good to do or not do when separating waste, at institutional level, e.g. codified knowledge in standards about measuring energy efficiency, at organisational level, e.g. when a company uses less-efficient production processes, and at national level, where e.g. regulation and legislation can put incentives for resource efficient behaviour into place. To promote a resource efficient way of life

[37] *The efficient use of resources can e.g. be manifested in the design of administrative procedures, if they are digitalised and virtual rather than material and face-to-face. The efficient design of processes will, in turn, lead to less use of natural, material, or energetic resources.*

knowledge should be 'harvested' and disseminated, which could e.g. be done through the standardisation of knowledge or in common EU regulations. The latter is of particular importance for some new member states, as it creates incentives to adjust national, regional and local policy frameworks. Enabling technologies for such a development would by 2019 e.g. be simple technologies to calculate the carbon footprint of a process or a product. In combination with a 'personal dashboard' it could inform citizens, entrepreneurs and managers about the effects of their decision-making. In parallel the market would start providing an increasing number of lightweight products and products made of reusable or recyclable materials. This would, in turn, meet a growing demand for this type of products driven by consumers who increasingly value products and services that can be re-used and are in this sense resource efficient. The time frame for this development is assumed to be five years.

- A second pathway, marked in bright yellow, – '**Enable Choice**' – builds on the technologies that provide real-time and individualised information about the impact of all buying (and production) decisions. The information transmitted through personal dashboards allows individuals to combine their efforts to lead a resource efficient life with playfulness. By 2017 citizens would be increasingly conscious of the price of resource inefficiency. The latter exceeds the purely monetary dimension and includes the price for health (care) and safety measures that have to be adapted to balance the effects of a resource-inefficient lifestyle. Alternative sources of energy (e.g. burning waste, which is of particular interest in Eastern Europe, while in Northern Europe some waste incineration facilities require supplies from other countries) combined with high-capacity-low-weight batteries would allow for a wide range of choices among different energy sources. Cyber-physical sensing systems would provide a wealth of data about the value-creation processes by 2019 and allow for individualised feedback about the resource balance of a person's lifestyle. Every individual could have a personal account of resources, granted by the time a person is born, that is diminishing or increasing in dependence of his/her lifestyle. In addition, individuals might be allowed to trade 'points' (or miles for that matter), which would be linked to certain privileges or access to scare resources. This would not only meet with a value of playfulness / gamification mentioned above but also lead to what can be called 'Awareness 2.0': awareness about the resource efficient lifestyle of community, a group of people, a house or a company. 'Personal dashboards' would be complemented by 'community dashboards' that would provide the information for individuals to think about ways to help society to become more resource-efficient.
- A third pathway – '**Region is at the Heart**' – (pale blue) could develop out of two contextual factors: a trend towards emphasising the region as a source for materials, products and services. Space-based technologies (satellites, remote sensing etc.) – available by 2017 – would support the monitoring, measurement and management of water, land, forest, and agricultural resources would help to increase productivity even in regions with high cost of labour. Moreover, these systems would be used to provide a direct feedback to citizens, as well as management, about the impact of their decisions at home and in organisations respectively. Through a 'personal dashboard' would every individual know about the effects that she causes with her behaviour. This information could be linked to earning 'points' heralding an increasing trend of the 'gamification' of business relations. Intelligent and lightweight materials would replace traditional material. Such a development would meet an increasing demand for urban farming, a phenomenon that addresses the wish for fresh and locally produced produce that is not transported around the globe. Finally, intelligent logistics would make smooth and highly efficient transportation available, connecting the different partners of the value chain. The timeframe for this development was considered to be rather short i.e. in two to three years.

Figure 4: Roadmap 'Resource efficiency' with three pathways



Source: European Cluster Observatory, prepared by VDI/VDE-IT and Technopolis Group

Roadmap 'Personalisation of Products and Services'

Personalisation of products and services refers in this context to all innovations that allow firms to provide tailored products and services, relative to personal demand and taste. Examples for personalised products and services are wearable technologies, smart meters, as well as personalised medicine. Participants see two pathways in the development of personalised products and services:

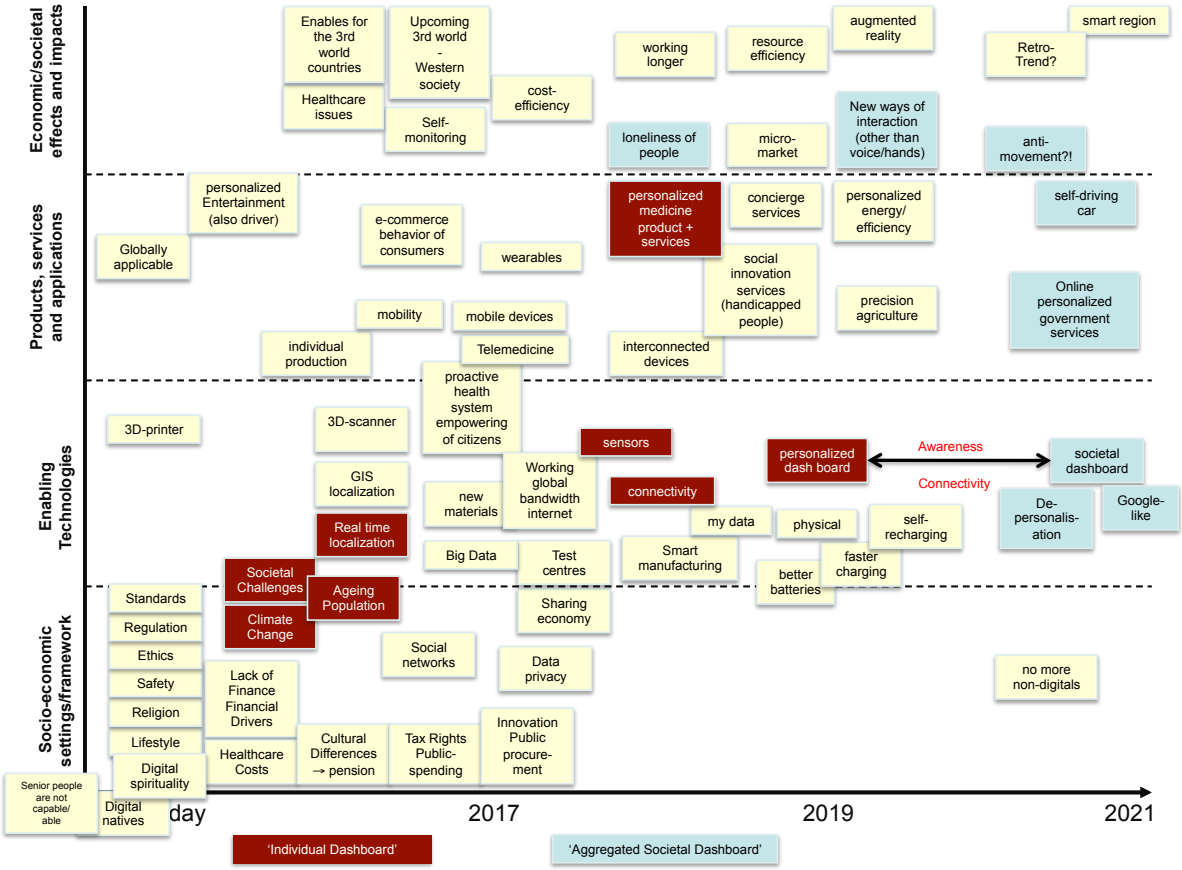
- The first pathway (marked in red) implies the development of an **individual dashboard of personalised products and services**. Departing from societal challenges, such as the ageing of the population or climate change, products, services and applications could feed information into a sort of dashboard that each individual would own. Using enabling technologies such as sensors, real time localisation and data-driven technologies, the dashboard would instantly provide access to a multitude of products, services and applications that could be accessed at the individual's 'fingertips'. For instance, such a dashboard could be used to manage interconnected products (e.g. smart homes, smart manufacturing, smart health) as well as services (e.g. personalised mobility services, e-commerce). As other societal challenges such as climate change could increase the need for overall cost-efficiency, people will face increased pressure to engage in self-monitoring. The dashboard on an individual basis will further allow bringing together other products and services that result out of the need to address societal challenges. The underlying enabling technologies of the dashboard are sensors, which facilitate the automated connectivity of the range of personalised products and services

(automatically sending a self-driving car when you need it). Finally, the dashboard is to be understood as a service (e.g. cloud-based) and could potentially entail a physical device to manage the dashboard, such as a tablet. The timeframe for this pathway was considered to be 2019 i.e. in four to five years.

- The second pathway – the '**aggregated societal dashboard**' – is marked in pale blue and could develop out of the individual dashboard of personalised products and services of the first stage. This societal dashboard would aggregate all the personalised dashboards on the individual level with the purpose of creating a basic tool for policy making. The user of the aggregated societal dashboard (i.e. the government or a community) might integrate the whole range of usage of personalised products and services that people manage with their individual dashboards. Certainly, privacy issues would arise out of such an aggregated societal dashboard. However, the dashboard could even have much broader implications for people besides the privacy issues. The complete personalisation of products and services as well as – to a certain extent – of governance could entail a feeling of de-personalisation that could have in turn implications for the wellbeing of people as well as on their perception of society, ethics and religion. As the dashboards make communal institutions (such as churches as places of gathering) less relevant, a kind of digital spirituality could emerge out of it. Furthermore, as the individual gains autonomy from its dependence on communities and the society because of the new ability of managing everything (from health to mobility and even production) with a dashboard, people could develop an increased feeling of loneliness. Especially with an ageing population, alienation of the individual from society could develop into a serious problem. Because of these issues, it could be possible that a sort of movement is founded against the aggregation of individual dashboards of personalised products and services.

The following figure highlights the two pathways among the overall socio-economic context, enabling technologies, products and services as well as the economic/societal effects and impacts.

Figure 5: Roadmap 'Personalisation of products and services'



Source: European Cluster Observatory, prepared by VDI/VDE-IT and Technopolis Group

Reflection on the results of the expert workshop

In reflection of the roadmaps and the discussion at the expert foresight workshop, the foresight team drew five conclusions. They concern technological, social and ethical aspects, environmental concerns, as well as a wider contextualisation vis-à-vis the mega trends.

- From a **technological** perspective all three roadmaps include the collection, processing and provision of large amount of data for the self-management of individuals. The data will be collected by an increasing number of digital devices that gather facts about the environment, individual behaviour, organisational processes and interactions. Data sets will be provided in real-time to be aggregated by larger systems at different levels according to the ever-evolving needs of different communities.
- From a **social** perspective all three roadmaps share the trait that individuals will assume an increasing responsibility for aspects of life that have so far either not been addressed at all or in a societal manner. Using real-time information people will be able to adjust their behaviour and tailor it towards meeting politically agreed societal challenges, be it climate change goals or the efficient use of energy and resources.
- Regarding **ethical** values a strong regional identity and a care for the wellbeing of the immediate environment in which people live are regarded as an important trend that was raised time and again in the discussions during the workshop. In this context the foresight team and

experts extensively discussed the need to explore synergies of regional cluster cooperation. Cluster initiatives in one region could explore opportunities for collaboration, e.g. at the organisational level, which could include the management of innovation processes, back office, analysis of common markets, or representation to the 'outside world', meaning the political arena but also the clusters in a national, EU or international context.

- Fourth, in all three roadmaps a concern for **resource efficiency** can be identified. New materials, lighter materials for decreased transportation, reused products or recyclable materials combined with smart logistics that make use of available transportation capacities, as well decentralised and production of energy from new sources are but a number of aspects that were shared by all roadmaps. This new emphasis on resource efficiency is likely to be a factor that companies will not be able to ignore in the future.
- Finally, the pathways detected in all three roadmaps are consistent with overarching findings from other foresight exercises, as analysed in the desk research (see Section 3.1 above). The continued importance of the wider societal mega trends identified in the desk research is reflected in the pathways that experts pointed to during the workshop discussions. It shows the multifaceted horizon of the trends representing similar developments in different field.

  For example, the trend "From Centralisation to Decentralisation" can be observed not only in political contexts (for example in trends such as "From Hierarchies to Networking" and "From Representative Democracy to Participatory Democracy"), but also in technology (for example in IT-Systems: From mainframe computers to personal computers to embedded systems to smart devices in smart environments).

The scope described by the three roadmaps and mirrored by the set of mega trends served as a framework for the following two steps of the foresight exercise: horizon scanning and scenario writing.

3.5 Horizon scanning

In contrast to detecting and describing mega trends, horizon scanning **aims to identify weak and diffuse signals** of still hazy emerging trends so that they can be examined in terms of their social relevance and potential consequences, both positive and negative. It allows connecting identified developments with changes in the wider context. A careful analysis of these weak signals can provide indications with regard to the conditions underpinning new developments. The main objective of the horizon scanning is to increase the sensibility of actors towards developments of likely importance, which may manifest themselves in the early stages as initially inconspicuous, thus leaving them undiscovered.

The horizon scanning applied here is an interpretative approach based on a software-aided text analysis using Atlas.ti[38]. It makes use of what is called "thematic convergence". The underlying assumption of the approach is that crossing points of two – maybe already well-known – themes (developments/trends) will represent "hot spots" for new developments. The more trends converge in one point, the more likely it is that a new development will arise from such a "hot spot". In order to identify such hot spots, the horizon scanning uses an elaborated set of text codes (the broader search field for text analysis is structured by the mega trends).

[38] *For a more detailed account see Bovenschulte, Ehrenberg-Silies, Compagna, Horizon Scanning – Ein strukturierter Blick ins Ungewisse, 2014 (electronic version http://www.vdivde-it.de/wir-ueber-uns/team/demographischer-wandel/TABBrief043_HorizonScanning.pdf)*

Every text is analysed by experts for the information units it contains. Every information unit (typically a paragraph) is coded with at least two different codes – e.g. “demographic change” and “biotechnology”. The horizon scanning system of VDI/VDE-IT includes some 1.000 text sources representing about 7.000 information units. Running the software based analysis across all coded texts then shows, how often the two codes have been referred to together (co-occourence). The co-occurences indicate possible hot spots for schemes and combinations of choice. Filters and boolian operators allow different approaches for analysis. The resulting potential hot spots (= combination of different topics) have been further analysed by experts using qualitative interpretation.

The horizon scanning yielded a number of results, directly linked to cross-cluster and cross-sectoral collaboration. They have been summarized into six groups of findings and will be presented in the following paragraphs, which are preceded by more general reflection about the horizon scanning output.

General reflection on the output from horizon scanning

The results that the horizon scanning yielded with regard to cross-cluster and cross-sectoral collaboration warrant a more general reflection about industry collaboration. The following is the result of an in-depth discussion of the foresight team and is meant to provide a wider framework for contemplating the future of cross-sector and cross-cluster collaboration.

Based on the results of the horizon scanning outlined above cross-clustering and cross-sectoral collaboration can be considered as an approach to address the increased complexity of today’s challenges and of the solutions offered by our societies. The complexity of challenges and solutions is visible in a number of aspects:

On the one hand, research and innovation policy has conceptually switched from detailed technology-oriented funding schemes to **integrated and mission-oriented RTD-programs**. The latter are guided by a way of thinking in terms of the grand societal challenges[39] (Health and Wellbeing, Environment and Climate, Mobility and Logistics etc. – see “Horizon 2020” of the European Commission or the German “High-Tech Strategy”), requires the ability of taking a 360 degrees perspective of a problem/challenge. The better developed this ability is, the higher is the probability to contribute to its solution.

On the other hand, economic thinking too, offers a concept that accounts for higher levels of complexity. In economic terms, the concept of **economic/industrial complexity** established by Hausmann *et al.*[40] shows, that significant competitive advantages of economies result from the ability to generate complex products and/or services as a hallmark for advanced abilities. The economic/industrial complexity is the basis for productive flexibility that is not necessarily “more of the same” (higher performance in efficiency etc.), but opens niches for “different” and new (disruptive) sources of value generation leading to a “uniqueness” of products (marked by complexity) that differentiates suppliers of one economy from those of another.

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[39] *Kuhlmann, S. & Rip, A., The challenge of addressing Grand Challenges – A think piece on how innovation can be driven towards the ‘Grand Challenges’ as defined under the prospective European Union Framework Programme Horizon 2020. University of Twente, White Paper, Twente 2014; European Commission (ed.), The Grand Challenge – The design and societal impact of Horizon 2020. Brussels, Directorate-General for Research and Innovation, Brussels 2012*

[40] *Hausmann, R., Hidalgo, C.A., Bustos, S., Coscia, M., Simoes, A. Yildirim, M.A., The Atlas of Economic Complexity – Mapping Paths to Prosperity. Harvard University Press, Boston 2013*

These findings, that today's challenges are framed as complex phenomena and that **industrial complexity is a main driver for future development,** are fully in line with an analysis of the mega trends (the original set of 10 mega trends as well as the set of 20 described in the mega trend update). As the examples below show, many of the mega trends attest to an increasing complexity. Moreover, these mega trends[41] entail a growing societal, as well as a technological complexity.[42]

Table 1: Societal and technological complexity of mega trends

Trends	Society	Technology
From Industrial Society to Information Society	++	++
From Forced Technology to High Tech/High Touch	+	++
From Centralisation to Decentralisation	++	++
From Institutional Help to Self-Help	++	+
From Representative Democracy to Participatory Democracy	++	+
From Hierarchies to Networking	++	++
From Either/Or to Multiple Option	++	++

For both types of increased complexity – in policy making and in industry – cross-cluster collaboration offers the potential to incorporate these trends in a constructive and competitive manner. In other words: The "competitive advantage of nations"[43] (regions, sectors etc.) nowadays seems to depend more than ever on the **capability to produce complex products** and related services.[44] The ability to manage complexity by building complex systems and integrating them to systems-of-systems is a strategy that allows actors to differentiate themselves from competitors and to develop unique selling propositions: The more complex the range of products is, the more knowledge has to be cross-linked and the less competitors with the same level of knowledge integration are to be expected.

Cross-sectoral and cross-cluster collaboration can be understood as **ways of building and maintaining competitive advantages** or even competitive exclusiveness in an increasingly more complex environment. They combine in novel and flexible ways to bring together and to coordinate a wide range of heterogeneous actors, who in combination can address today's complex challenges. Established processes and structures become more permeable and flexible, so value creation (especially in a knowledge economy) increasingly takes place outside clearly identifiable sectors and industries.

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[41] Naisbitt, J., Megatrends – Ten New Directions Transforming Our Lives. Warner Books, New York 1982

[42] The brackets refer to the estimated impact of the trend on societal and technological developments, with two pluses imply a higher impact than one plus, without referring to any "positive" or "negative" influence.

[43] Porter, M.E., The Competitive Advantage of Nations. Free Press, New York 1990

[44] Trantow, S., Hees, F., Jeschke, S. (2011): Innovative Capability – an Introduction to this Volume. In: Jeschke, S., Isenhardt, I., Hees, F., Trantow, S. (ed.) (2011): Enabling Innovation: Innovative Capability – German and International Views. Berlin, Springer

Consequently, the capability of cluster initiatives to manage processes across such dissolving boundaries becomes a key success factor.

Specific results of the horizon scanning

First, cross- and cross-sectoral collaboration can so far **not be observed widely or as a fully-fledged approach across Europe** or in other world regions. Indeed most of the examples of this type of collaboration take place or have their origin in the EU with hardly any examples stemming from other parts of the globe. In Europe, there are a number of prominent and highly visible examples such as the *Cambrige cluster* or the *Dortmund Project*. The *Cambridge cluster* has been built around 5 thematic different science parks (Cambridge Science Park, St. John's Innovation Centre, Babraham Research Campus, Granta Park, IQ Cambridge). The *Dortmund Project* is in comparison of a much smaller scale and scope. It allows for local/regional synergies and has led to the creation of some 70,000 new jobs in high-tech related industries as an answer to the decline in traditional industry (in the case of Dortmund it was steel, coal and beer).[45]

Second, "**geography matters**" for cross-ing, in two ways: On the one hand, for cross-ing to start off, face-to-face contacts seem to be an important precondition. Despite the ubiquity of telecommunications and the low cost of individual transportation the initiative for exploring the benefits of cross- collaboration is often born out of personal contacts in close proximity. This result is well in line with the discussion at the expert foresight workshop, where it was held that it is regions, which are at the heart and the beginning of ing. On the other hand, the horizon scanning confirmed a result found in the survey of managers, namely, that collaboration patterns vary across Europe. While collaboration of SMEs can be found in northern as well as in southern Europe to focus more on the region, the geographical focus of collaboration is wider in the remaining parts of Europe.

A third group of findings relates to the relationship between cross-ing and innovation: **Cross-ing is a way to unleash the innovative potential of clusters**, which could otherwise remain dormant. Each cluster initiatives is on its own a mechanism to bring together, manage and develop the knowledge, resources and creative energies of its stakeholders. When cluster initiatives collaborate they bring together an even more heterogeneous group of stakeholders. Diversity in terms of sectors, research disciplines, market access etc. and the ability to seize its opportunities is particularly important for the development of complex products and services. Thus, cross-sectoral and cross-cluster collaboration can be expected to develop specifically in this are new and innovative solutions and products. The same argument applies to seizing the opportunities stemming from open innovation. Sharing knowledge among and having customers and developers participate in the value creation is one way to tackle complex challenges. The additional benefit clusters bring to open innovation is that they can rely on their networks to gain knowledge from many different people across the world. With cross-clustering that openness and permeability of boundaries is increased albeit in a controllable and structured manner enabled by the trust among the collaboration partners.

Fourth, the **development of cross-clustering is favoured if a critical mass of different companies** as well as supporting institutions that share a collective capability to develop new products and processes are present in the different clusters that collaborate. In other words, a right balance between heterogeneity of backgrounds – market access, supplies, research experience – and technical productive complementarity has to be struck. In this context ICT is considered as a key enabling technology for the creation of cross-cluster collaboration. The same holds for other enabling technologies that are

[45] *See Kortmann, Das „dortmund-project" ist auf der Zielgeraden, 2010 (electronic version: http://www.derwesten.de/staedte/dortmund/das-dortmund-project-ist-auf-der-zielgeraden-id3341018.html)*

by definition cutting across existing industries and sectors. By the same token, digitisation and the opportunities linked to the exploitation of big data present a way for SME to engage in innovative experiments, but also for identifying possible collaboration spaces in which to develop new products. It opens the possibility for SMEs to partner with larger companies in order to gain access to new markets and participate in innovation processes. This finding is specifically relevant in light of the broader role given to SMEs by one of the interviewees (see Section 3.1 above). There it was held that successful SMEs are nowadays not necessarily bought straight away by “Big Industry”, but are kept in the collaborative ecosystem (access as well for competitors) to allow for a more sustainable innovation.

A fifth group of findings concerns **means to enable** cross-clustering. There is no school of thought or a specific tool box (yet) for the promotion and management of cross-clustering. It seems that the same skills and experience that make good cluster managers is also required for the successful management of cross-cluster collaboration. So far, that is a central result of the horizon scanning exercise most cross-cluster activities have been in the area of networking and information exchange. This point is well in line with the one made above, that regional proximity is a key success ingredient for cross-clustering.

Sixth and finally, the **benefits of cross-clustering** concern the ability to address more complex issues. Cross-clustering can provide a means to address global or big societal challenges, as different clusters bring together the sets of actors required for the broad range of issues that such challenges pose. For example the transitioning into a sustainable, resource-efficient society as adaptation strategy to deal with challenges stemming from climate change and demographic shifts will require intimate knowledge of a number of divers markets, for example in cleantech, the maritime and energy sectors. Moreover, cross-clustering within regions helps to avoid fragmented investments. Funding efforts can be bundled in order to efficiently allocate limited financial resources. Strong regions are more likely to receive resources: this includes (but is not limited to) financial, human and natural resources. With collaboration, regions can learn from each other and develop shared innovation strategies in order to gain importance in global markets.

Against the background of these considerations and of the results of the other strands of the foresight exercised the following Section will present scenarios to explore the future of clustering.

4. An exploration of the future of clustering

The following Section presents a vision of the world in 2025 expressed in two specific scenarios set in the same wider context (called "baseline scenario"). The purpose of the scenario is to explore to what extent cross-sectoral and cross-cluster phenomena are to become more important for the economic development of regions and entire innovation systems, the challenges that will arise from such developments, as well as the issues that cluster policy will have to address. In other words, it serves to explore three questions: how can cross-clustering play out, what challenges will it pose, how can cluster policy and cluster management respond to these challenges?

A **scenario** describes possible events or a series of events in the future i.e. it is a 'story' illustrating visions of a possible future or specific aspects of a possible future combining known facts with trends and key drivers.[46] The specific scenarios spell out particular sides of the baseline scenario and have been developed inductively, i.e. the emphasis of inductive scenarios is on bottom-up development combining a rich source of materials[47]. The building blocks for the scenarios are the taken from results presented in Chapter 3, i.e. the roadmaps of the expert workshop, the horizon scanning the output of the survey, the interviews and the desk research. While the scenarios draw on the roadmaps developed by experts during the workshop, the former are more specific and analytically consistent than the roadmaps.

The **purpose** of the scenarios is not to predict the future but rather to stimulate strategic thinking, creativity and communication about the future of cross-sectoral collaboration and cross-clustering. They are a means to draw out particular aspects of the challenges ahead that deserve scrutiny and possibly action. In this sense, the material presented in this Chapter is not only to be considered as an end of the analysis, which has led to policy recommendations presented in Chapter 5 but also as an input for a continuous discussion about the future of clustering. It is an invitation to participate in a debate of how that future might look like and an analytical basis for that debate, as foresight is not an exercise in predicting the future but rather a participatory process of intelligence gathering and vision building, for decision-making and for mobilising joint action.

The subsequent **analysis** of the specific scenarios examines overlaps i.e. we identify areas of conflict and alignment between "Smartness" and Resource efficiency". These areas of overlap serve two purposes: they provide us with a sense of the types of industry involved in creating the vision of 2025 and point to potential tasks of cluster initiatives. Both results will allow drawing conclusion with regard to cross-clustering, as they will highlight intersections between the two specific scenarios and, thereby, needs for interdisciplinary and cross-sectoral collaboration

4.1 Baseline scenario: The world in 2025

The world in Europe in 2025 is characterised by ubiquitous digitalisation of almost every sphere of our daily life. The Internet of Things has established itself far beyond the manufacturing sector and now increasingly takes its way into the private sphere of society (tracking, sensing, big data approaches). The social structure has become increasingly fragmented: A constant rise in **value pluralism and a**

[46] *See http://www.foresight-platform.eu/community/forlearn/how-to-do-foresight/methods/scenario/*

[47] *Farrington et. al., Exploring the Future through Scenarios, 2013 (electronic version: https://www.iriweb.org/CMDownload.aspx?ContentKey=799dcf13-eee6-4a2e-a03b-2aefde509a13&ContentItemKey=40e0f520-d67f-4c66-ad69-7f41d9c4a8c8)*

growing degree of individualisation are reflected in social structures and the "societal division of labour". In some European countries, more and more parts of the structures and activities that underpin the "social cohesion" of the private and family environment have been transferred to public or governmental institutions. On the other hand, in several other countries the performance of public institutions is stepwise decreasing. The shock waves caused by the financial and economic crises are still present in some southern European countries and family structures regain their traditional importance. A general motive in nearly all European countries (and beyond) is the growing participation of citizens and a shared responsibility for social issues between public institutions, private companies and civil society.

The global urbanisation continues and requires an inclusive and forward-looking urban development in Europe too. To this end, it will be necessary that more than today **people with diverse backgrounds and experiences live and work together**, which requires in turn a simplified recognition of professional qualifications, as well as well-functioning programmes that help to integrate people into labour markets, but also instruments to harness the business opportunities and entrepreneurship arising out of such a setting. In this way, new "industrial districts" are established in urban agglomerations, which serve as an "economic tissue" that allows for a high openness to cross-sectoral cooperation. New forms of cooperation increasingly replace mechanisms of integration. Within these new forms of cooperation small companies are able to retain their autonomy because of reciprocal outside-in and inside-out transfers of knowledge (Chessbrough 2003) that allows for greater potentials within an "ecosystem" than it would be possible through exclusivity and absorption.

Agglomerations increasingly turn into **smart cities** – and somewhat more slowly – into smart regions. At the same time, cities establish themselves as centres for knowledge and production as well as laboratories of alternative development concepts that unfold their innovative effects apart from established institutional structures. For instance, the maker movement[48], as well as transition town-concepts[49] offer variety of opportunities for participation and co-creation as well as for the development of novel solutions.

The **broad involvement of customers and citizens** at large in the articulation of research and innovation needs, as well as in the development of solutions to has become a salient feature of the innovation system. To share knowledge among and having customers and developers collaborate in the value creation is one way to tackle complex challenges.

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[48] Maker movement or maker culture refers to a "subculture representing a technology-based extension of DIY [do-it-yourself] culture. Typical interests enjoyed by the maker culture include engineering-oriented pursuits such as electronics, robotics, 3-D printing, and the use of CNC tools, as well as more traditional activities such as metalworking, woodworking, and traditional arts and crafts. The subculture stresses a cut-and-paste approach to standardized hobbyist technologies, and encourages cookbook re-use of designs published on websites and maker-oriented publications." (MacMillan 2012). An important notion of the maker movement is the idea to personalize products. The maker movement can be transferred as well to economic settings resulting in the opportunity to reinforce local production and – possibly – to re-shore production processes and capacities. In another expression the maker movement or culture refers to people who champion an approach that avoids throwing away broken goods and wasting resources, and instead repairs and reuses them. Therefore, an increasing number of repair cafés etc. provide fixing dysfunctional products and goods by professional advice and machinery.

[49] "A Transition town, or more generally a transition initiative, is a grassroots community project that seeks to build resilience in response to peak oil, climate destruction, and economic instability by creating local groups that uphold the values of the transition network." (Wikipedia. Retrieved 15 May 2015.) Originally developed and applied in the UK, the concept was picked up by initiatives around the world, not least when large cities (e.g. Detroit) faced a breakdown of their traditional industrial structure. In order to keep fundamental processes alive, the initiatives aim at strengthening the social capital of the town in order to install structures resistant to economic changes.

> *„We truly believe that crowdsourcing and open innovation have the potential to solve the biggest issues facing society. Some of the biggest leaps in technologies and innovation in science have come from approaching old problems with fresh perspectives not constrained by old dogmas. It took a chemist to overthrow the old tenet in biology that genetic information only flows in one direction (DNA > RNA > Protein), and it revolutionised our understanding of how viruses like HIV work and resulted in the awarding of not one, but two Nobel Prizes. We look to science more and more to solve these big problems and co-ordinating the efforts of large crowds made up of individuals that each have something different to offer and can build on each other's ideas seems a smart way to solve them.“ (Ferrari & Fidanboylu 2013)*

While these solutions serve, on the one hand, the development of concrete answers to questions of everyday life, they represent, on the other hand, the attempt to take on complex global challenges such as a continuously high use of resources and the associated climate change. The effects of climate change and dwindling natural resources are met by shrinking rural areas and urban agglomerations, and the development of technical solutions for the production of resilient and flexible systems becomes more important in different ways. At the same time, it is important to identify new ways in production to reduce the dependency on natural resources (“peak oil”).

The **efficient use of resources** (material and energy) has established itself as a key factor of economic and societal development. After almost a decade of binding climate targets, that where often agreed upon only as a minimal consensus, the follow-up costs of environmental damages and extreme weather events, as well as the high prices for fossil fuels now actually lead to more efficient use of resources. Production processes are digitally connected and controlled and optimised in real time, which entails a high cost (also in terms of energy use) but has led to the establishment of a complex infrastructure that eventually generated significant savings. In industry, however, efficiency was only one driver of digitalisation. Greater integration and manufacturing flexibility, product customisation, shorter product life cycles while also enhancing reuse and recyclability, required new production concepts. In addition, the resulting Industry 4.0 opens for diverse stakeholders and because of the increased flexibility also increasingly acts across sectors. Next to value chains, variable value-creating networks emerge, which predominantly express themselves at the regional level (many of those networks are based on cluster structures that show an even stronger integration of partners and facilitate cross-sectoral connectivity. Especially production-clusters can be regarded as forerunners of intersectorial collaboration.

Public policy partly acts as a trigger, but also as a key driver. From the realisation, that phenomena at the local level (resulting from overarching trends) represent sometimes widely different challenges, the strategy has been created to help individual key regions to greater autonomy. Against this background, regional networks and lasting alliances assume a modified core role: Not only the activities within individual network structures, but also the cooperation of several of these networks turn out to be decisive for the solution of the challenges at the local and regional level.

> *““We are getting away from thinking about clusters as purely sector specific. Now we use cross-sector clustering to identify smart specialization opportunities. Businesses often want local growth first, before expanding abroad. So we must identify the low-hanging fruits of opportunity in each of our regions, connecting our sector strengths with societal and consumer trends.? Clusters are a glue to instigate change, an honest broker, often more neutral and trusted than trade associations. But in the past*

they have often taken a passive role, now is the time for action, clusters can drive growth for the future."[50]

Against the background of the baseline scenario of the world in 2025 two specific scenarios will be developed in greater depth, which emphasise "smartness" and "resource efficiency" respectively.

4.2 Two specific scenarios: "smartness" and "resource efficiency"

The **two specific scenarios** concern particularly pertinent developments for the future, dubbed "Smartness" and "Resource Efficiency". The choice to deepen these two aspects has been deliberate.

First, the importance of these two topics is based on the assessment of the experts in the discussions during the workshop[51], as well as the high rating they received by cluster managers in the survey.

Second, there are empirical reasons for putting an emphasis on both aspects. They capture very likely developments and it is no surprise that both aspects are related to a number of mega trends (see above).

- "**Smartness**" addresses issues of a comprehensive digitalisation of all spheres of life and its consequences. Due to real-time data sensing and processing representing state of the art (predictive) analysis, the range of (personalised) options increases and enables the fusion of different data spaces. The policies of government and international organisations have promoted research and innovation into the direction of a more networked society under the heading of e-mobility, smart grid, smart city and the like. In addition to policy there has been extensive public, and even more private investment into these developments.
- "**Resource efficiency**" addresses the role of production and consumption patterns for reduced use of natural resources and thereby reduced environmental impacts and cost. This aspect is deemed important, as it is the result of many political, economic and technological drivers. Concerns about climate change, the supply of economically relevant materials and about a decline in the absorptive capacity of the ecosystem have put resource efficiency on the top of the political agenda. The rising middle class in emerging economies and the concomitant surge in consumption and, hence, in the demand for resources cannot be met with existing product and process efficiencies. Finally, companies discover resource efficiency as a strategy to gain competitive advantages.

Hence, the foresight team decided to explore the consequences of these topics more extensively. Each scenario is described along the following lines:

- **Production and consumption patterns** addresses the activities and roles of companies and consumers i.e. value creation, value chains and patterns of production and consumption.
- The **role of governments** addresses the role of regional or national governments in terms of concrete activities within each scenario, i.e. not in terms of how they paved the way or supported the occurrence of the specific scenario.
- Information about the **technological developments**, as well as

[50] *Interview with David Furmage, Project leader on Cluster 2020, part of the European Creative Industries Alliance conducted on 27.08.2014 and approved by email on 25 June 2015.*

[51] *Material developed in the third roadmap during the expert foresight workshop (Personalisation of Products and Services – see Chapter 3.4) has been incorporated in both specific scenarios.*

- **new products and services** that are possible on the basis of the technologies and to enable the scenario to evolve. This aspect will necessarily make reference to the first point (production and consumption patterns) and also to social innovations that create a demand for new types of services.
- **Values** that reflect or have enabled the scenario are discussed to complement provide an enriched background information.

4.2.1 "Smartness"

The **urban agglomerations** mentioned in the baseline scenario are home to millions of people, partly native and partly immigrated from other countries. The infrastructure will be a mix of decades old and trusted, but also modern structures built from new materials and with new technologies, laying the ground for new functionalities. A major challenge in these urban regions will be the continuous adjustment of infrastructure to deal with a growing and changing population. The inhabitants of the urban agglomerations will demand security, public services, education, employment and health care services; they will want to engage in cultural and social activities. Furthermore, urban spaces are productive areas combining knowledge creation ("education"), creativity ("diversity") and production ("competitiveness").

Since these urban areas are very diverse with regard to their population, **connectivity has become a major driver** in order to provide and develop the necessary goods and services. Not only are people connected to each other *via* smart devices, but objects themselves – from the light bulb in an apartment to the self-driving car on a road – are linked to each other and via the Internet. A wide variety of areas of life is by now considered to be "smart": living (from Smart Homes to Smart Cities), mobility (Smart Cars), infrastructure (Smart Grids) and production (Smart Manufacturing) as well as many other areas of life (Smart Health, Smart Work, Smart Leisure).

From these developments a key challenge arises for **companies** situated within the urban areas.

- On the one hand, they are able to gather and analyse vast amounts of data on their customers. This leads to an exact knowledge of specified demands and needs.
- On the other hand, companies need to provide more and more individually tailored products and services to their customers.

Competition in densely populated areas is strong and in order to fulfil the various demand-patterns, companies need to be highly adaptive and responsive in their way to secure resources (energy, material and human capital). In these highly connected networks the demand-oriented use of big data, the use and recycling of raw materials and the ability to control complex logistics becomes a priority. At the same time, the ever-growing infrastructure and the need for redevelopment of urban areas becomes another responsibility of those companies that make strong use of infrastructural conditions. In this highly connected and integrated world, resilience becomes a key aspect.

With rising complexity, seemingly insignificant failures can result in disastrous consequences. The need for **back-up systems grows**. Companies are dependent on a network of suppliers, buyers and other "supporters" and these networks are subject to the aforementioned fragilities of interdependencies. Manufacturing companies are not only relying on a complex external network but also an interlinked production chains that are increasingly connected via the Internet. Although providing flexible and independent means of manufacturing, these systems are also threatened by cyber-attacks. While wireless networks are an essential enabling technology for companies to create the digital infrastructure, another key factor in this context is the energy necessary to operate all the connected devices.

Energy cost depend on the provision of (smart) grids and the abilities to produce and store energy. Especially in urban areas with high numbers of devices (mobile and stationary), energy demand is still growing.

Municipal and federal **governments** are faced with the task of providing the regulation necessary to underpin a secure and well-ordered urban life. They need to manage the interests of many different stakeholder groups. These requirements put new strain on governmental institutions. Large, diverse groups of citizens represent a variety of opinions, needs, cultural habits, lifestyles and wants. With the assistance of social media and connected devices, formulating viewpoints and opinions on current events has become very easy and voters are more likely to change their positions quickly. In addition to that, social networks allow for the instant formation of large, vocal groups that are able to influence policy-making. Governments had to embrace the new forms of expression of political opinions. The key challenges for governments and their agencies are dealing with the changing role of privacy, security and inclusiveness.

- The understanding of **privacy** is changing in two ways: on the one hand, people are living in very densely populated areas and are sharing a number of common goods. The ability to provide housing and options for retreat from social interaction is a major task for politics. On the other hand, the role of privacy extends from the physical into the digital sphere. Here, governments are engaged in the transformation of traditional modes of democratic participation into new, progressive ways of representing the will of the people.
- **Security** is closely linked to the aforementioned complexities in infrastructure, value chains and energy grids. Vulnerable not only to physical attacks and failures, these systems are also threatened by cyber-warfare. Governments are tasked with providing security and insurance against these risks.
- Finally, the **inclusion** of all citizens in the digital transformation is another key challenge for public institutions. With more and more people active on the Internet, expressing their (political) opinions, organising themselves politically, and governments allowing participation through digital media, policy makers need to address the fact, that not everyone is willing or able to be active in the “digital public sphere”. A digital society needs to deal with outsiders and governments are faced with the role of developing solutions that enable everyone to participate in the digital society.

Technological developments influence all aspects of daily life and are very dynamic and increasingly complex.[52]

- For example, prototyping for the **Internet of Things** not only deals with developing new hardware, but also with integrating future application through the interaction with software. On the other hand, software that might have been developed for one specific use is transformed through interaction with other smart objects. In a society where most of the infrastructure is connected via the Internet, technological progress needs to address questions about information security and standardization for hard- and software. At the same time, technological

[52] *For a discussion of the industries that develop the technologies referred to in this scenario see the work on emerging industries done within the European Cluster Observatory, in particular on digital industries, mobility industries, logistical services, environmental industries, advanced packaging and biopharmaceutical/pharmaceutical industry. For an overview see European Cluster Trends, Preliminary Report, European Commission, Brussels 2014; for a detailed discussion see also Specific Trends Reports for 10 Emerging Industries, European Commission, Brussels 2014*

systems with their embedded intelligence, measure and evaluate warning signs and automate appropriate responses to potential threats.

- **Companies** have established highly flexible and adaptive processes and organizational structures in order to deal with rapid technological and social developments. In order to cope with external influences such as dwindling natural resources and climate change, processes are designed to be efficient and value-oriented. Recycling and retrieval of valuable elements and materials from technical systems and devices has become a key factor for lifecycle-processes, while waste is used to support energy production. Directly contributing to new products and services are the consumers. Through their choices and their expressions in social media and indirectly through the amount of data consumers provide, companies are using consumer insights during their research and development process, as well as their marketing and sales phase to develop and market innovative solutions.

- The backbone of the **smart city** will be a smart grid, which will connect the regions of or Europe and will ensure energy supplies at high efficiencies. Energy will come from a variety of sources and include “smart solutions” for the production, distribution, transmission and storage of energy, such as power-to-gas energy storage or decentralised storage in cars or household devises. Technologies for the collection, analysis and distribution of data will underpin these developments. The smart city will rely on smart logistical services where the different modes of transportation are interconnected. While people will be able to chose between different ways to reach their destinations, goods and material will be routed through cities automatically.

- As mentioned above, a **connected infrastructure** that encompasses not only mobile devices but all sorts of sensors and other data-driven objects, has become the enabling technology in urban areas. Mobility, energy and production – all these areas are connected and managed by increasingly sophisticated technical systems, as well as algorithms that reach their decisions by analysing the data companies and people create. At the same time, these systems are able to provide feedback to their users at both an individual and collective level. Citizens no longer deal with multiple online profiles. Instead, a seamless identification in the digital world has become a key aspect in order to enable people to move through smart environments. This technology is seen as the first definitive step towards an integration of the physical and the digital world, removing barriers between the individual and his digital representation.

Cyber-physical sensing systems would provide a wealth of data about the value-creation processes by 2019 and will lead to a wide range of **new products and services**. For example consumers receive a wide information about their behaviour and the impacts their behaviour has on the environment, on climate but also on other systems, such as the smart city, the smart grid or the traffic. This information will be used to provide feedback information to actors so that they are enabled to adjust their behaviour. Such information-based services will inform citizens, entrepreneurs and managers about the effects of their decision-making.

The smart urban connection appears to be an enticing goal. But within this scenario, smart is understood as a means to improve the quality of life instead of a goal in itself. With all the developments described above, a change in **values** and norms is undeniable. While the path towards a smart urban connection appears to be technology-driven, the emphasis on the human factor cannot be ignored. The complexities of life in urban areas with its multitude of options lead to the development of an equally varied set of values. Companies need to address growing environmental concerns, sustainability issues and questions of energy and resource efficiency. These values can have a decisive im-

pact on their consumers. While developing "smart" products and services, companies need to centre their efforts on the needs of people and not base innovation on technological possibilities alone. Privacy and security have become key aspects of the smart urban.

4.2.2 "Resource Efficiency"

By 2025 the continued urbanisation will lead to a growth and concentration of the population in large urban/metropolitan areas. The territory between these areas will be characterised by a rather low population density. These regions have been struggling to provide the necessary infrastructure for social life and economic activity be it security, public administration, health care or education and training, as well as to sustain a fair degree of cultural activities.

The challenges have only been overcome by developing and building **strong regional identities**, i.e. the region is at the heart of production and consumption activities.

> *"The challenges of meeting the basic needs of humanity are mounting, as climate instability caused primarily from reliance on fossil fuel-based energy systems is coupled with global economic uncertainty […]. As localities throughout the world seek to address this dual challenge, the potential of creating 'green jobs' within a 'green economy' has increasing appeal […]. Some communities have been pursuing this aspiration through regional green cluster initiatives aimed at promoting the growth of a local sustainable energy sector in order to facilitate a transition to a more sustainable green energy economy."* (McCauley & Stephens 2012)

In their sourcing of inputs, especially energy, critical pre-products or human resources, **companies** focus on the region. They design their products in such a way that they last reliably, can be repaired or easily disassembled and recycled. Companies would use a larger share of recycled materials for simple parts of their products, which is also possible due to the fact that product design has been consciously driven to support recycling and a "zero-waste" approach. To this end companies in a region closely collaborate and enable an industrial symbiosis in their regional innovation eco-system: the discard/waste materials of one firm are used as input by another, waste streams are in general much less hazardous than today, there is less land-filling and incineration across the whole of Europe. The symbiosis is thought in a regional innovation ecosystem, as the logistics is not entirely climate neutral yet and some outputs/inputs are not transportable over long distances. Companies widely share services, utility, and by-product resources across different industries in order to add value, reduce costs and improve their economic, environmental and climate performance. Importantly, the symbiosis occurs primarily not along the value chain but rather across different value chains and industries. In sum, entrepreneurs /management consider these aspects of a as merely another cost on their life and business respectively but rather as an opportunity. The consideration of resource efficient aspects, leading to 'zero waste'-production and consumption, enables new choices and differentiation strategies.

Governments have fostered this development through procurement policies that put incentives to be innovative in terms of product and process design, which foster recycling and reuse or thinking in terms of a circular economy. Moreover, governments and European institutions have radically redesigned their governmental services, which are all based on eco-efficient processes now.

> *"The green biotech cluster, founded in 2008, is a cluster of companies active in the green biotech industry, such as plant breeders, seed producers and companies providing breeding support by testing products or providing machinery. It is a cluster composed of competitors as well as complementary companies; 10 of the 21 member companies are SMEs. The main drivers in founding the green biotech cluster were four big seed compa-*

nies. Since it was not the knowledge institute that sparked the development of the RIS, but based on the fact that the majority of the companies emerged of a long technological tradition in this region, we find here an example of an ex-post regional innovation system. The member companies are geographically clustered, as all companies are located within a circle of 30 kilometres. The cluster activities are financed for 80 % by company contributions, whereas 20 % comes from the central municipality. The cluster organization makes use of company resources in the form of working groups in order to execute its tasks and can therefore be regarded as a virtual organization supervised by the board of the CEOs and the cluster coordinator, the only employee of the cluster organization. There are two gatherings per year where the board and the workgroups meet. The board meets 5 to 6 times per year and the working groups meet 4 to 6 times per year. Furthermore, there is a lot of informal contact among the member companies, since the distances are small: on open days, receptions, and other networking moments. This informal contact has to be distinguished however in most cases form straight innovation cooperation contact, since this regionalized innovation system relies more on cluster independent collaboration contact on the national and international level." (Garbade, et al. 2012)

Technology will play a major role in this scenario[53]. The environmental industries for bringing about the technological change required for the overall development, as they enable the circular economy to evolve. New technologies will enable recycling of formerly unrecyclable materials (especially highly integrated electronic parts that formerly have been shipped to Africa or Asia where "recycling" occurred in a precarious manner).

- Moreover, new **sources** of energy and material production, not least from the open sea, will be developed to preserve the energy and resource security that is required for this scenario. Advance will also need to be made in the area of intelligent and lightweight materials, which will replace traditional materials

- Such developments would meet an swelling **demand** for farming that caters increasingly to the resource needs of industry and implies that less materials are to be transported around the globe. New approaches to packaging and to packaging material, linked to information technology and logistical systems will allow to preserve produce longer and/or to make them part of circular resource systems.

- In as much as raw materials have to come from further away and products will be distributed over long distances, they are from sustainable mining with considerable smaller ecological rucksacks than today due to almost climate-neutral **transportation** of imported materials. It is here where new logistical services and mobility technologies will come to play a significant role.

- **Companies** have established (eco-) efficient processes and their Kaizen-approach focuses on "lean and green" issues with their employees espousing a strong orientation towards these values, which have also been encouraged by a strong sense of regional identity. Companies

[53] *For a discussion of the industries that develop the technologies referred to in this scenario see the work on emerging industries done within the European Cluster Observatory, in particular on environmental industries, blue growth industries, digital industries, mobility industries, logistical services, advanced packaging and the creative industries. For an overview see European Cluster Trends, Preliminary Report, European Commission, Brussels 2014; for a detailed discussion see also Specific Trends Reports for 10 Emerging Industries, European Commission, Brussels 2014*

only produce mainly with “green energy”, which is enabled by an overproduction of regional energy based on technologies for new renewable energy production, storage and an all-flexible smart grid. Households receive energy from decentralised and regional sources.

- At a large scale **citizens** are not only consumers and employees but rather ‘prosumers’ of bulk resources. While the smart grid has enabled this development in the energy sector, 3D printing has had a similar effect in other industries. Alternative sources of energy (e.g. clean burning of “waste”, including biological “waste”, which is of particular interest in Eastern Europe, while in Northern Europe some waste incineration facilities require supplies from other countries) combined with high-capacity batteries would allow for a wide range of choices among different energy sources.

These choices would be enabled on the basis of enabling technologies such as sensors, real time localisation and data-driven technologies, and being fed into individual dashboards of personalised **products, services and applications**. Departing from societal challenges, such as the ageing of the population or climate change; products, services and applications could feed into a sort of dashboard that each individual would own. Space-based technologies (satellites, remote sensing etc.) – available by 2020 – would support the monitoring, measurement and management of water, land, forest, and agricultural resources would help to increase productivity even in regions with high cost of labour. Moreover, these systems would be used to provide a direct feedback to citizens, as well as management, about the impact of their decisions at home and in organisations respectively.

- Through the ‘**personal dashboard’** – a further development of individual health tracking including now ecological impact and footprint analyses – would every individual know about the effects that she causes with her behaviour (this can be seen as a widening of today’s “quantify self” movement). The dashboard will also be used to provide for the infrastructure in rural regions, e.g. for health care. In face of an ageing population and given the thinner (than today supply with health care in rural regions), people will face increased pressure to engage in self-monitoring of their health, in order to allow for the most (cost-) efficient provision of health care. Thus, the long-term perspective of personalised health care services (that already exist today, to a certain extent) could require individuals to control many more factors with implications to their health, such as nutrition, fitness or medication.
- This information could be linked to earning ‘oxygen points’ (or ‘miles’ for that matter), heralding an increasing trend of the ‘**gamification’** of business relations. Every individual could have a personal account of resources (number of ‘oxygen points’), granted by the time a person is born, that is diminishing or increasing – ‘breathing points in or out of the account’ – in dependence of his/her lifestyle. In addition, individuals might be allowed to trade ‘oxygen points’ (miles), which would be linked to certain privileges or access to valued resources. This could lead to what can be called ‘Awareness 2.0’: awareness about the resource efficient lifestyle of community, a group of people, a house or a company. ‘Personal dashboards’ would be complemented by ‘community dashboards’ that would provide the information for individuals to think about ways to help society in a region to become more resource-efficient.

A set of **values** will have evolved that is characterised by a renewed emphasis on the quality, reliability and durability of a product and services. These aspects have become important buying arguments. Short product life cycles are only accepted if they enable 2nd and 3rd use of quality product or the material they are assembled of. Mirroring the aforementioned resource conscious employees, consumers increasingly value products and services that can be recycled or re-used and are in this sense resource efficient.

- Another value concerns **personal responsibility** for one's own life, as well as the well-being of the community people live in and the region they feel attached to. Being aware and informed about the impact of a person's life style on the environment and climate in general and the region's performance in particular is important for individuals and communities, as they wish to lead a "good life" – for themselves, with their neighbours and for the environment in general. It is for their region that people are ready to take action, to get involved, to share their creativity (or to pay a premium). It is also regional sources that people tend to trust and where to seek solutions for the issues at hand.
- One major factor that has contributed to the social acceptance of this value is the fact that **luxury brands** – in industries as varied as cars and fashion – have become forerunners in resource efficient ways of production and played a pivotal role in brining about a more resource efficient lifestyle. The reasons for their importance is that they secure suppliers of resource efficient products and services a higher margin and, thereby, room to experiment, to innovate and to manoeuvre through dire phases until mass markets provide for the necessary scale, as well as the fact that luxury carries an allure for a lifestyle that might later be imitated by other strata. In addition to contributing to the acceptance of this value the luxury segment of markets has also led the way in economic terms, since the trickling down has increased the scale of production and reduced cost, while avoiding rebound effects.

While the trend towards higher resources efficiency has been demand-side driven, companies were not be able to ignore it due to a change in the pricing of raw materials. By 2020 citizens would be increasingly aware of the price of resources and conscious of the price of resource inefficiency. At the same time, the fuel price is supposed to rise again. To foster a permanent development independent of the changing market price, governments have changed the ecological tax into a dynamic resource tax.

4.3 On linkages between the two specific scenarios

The two specific scenarios were the basis for an extensive discussion about the future of cross-clustering and cross-sectoral collaboration at a scenario workshop held by members of the project team. During the discussion the team identified a number of issues and challenges that are characteristic for both scenarios and that, therefore, seem to be of particular pertinences for the future of cross-clustering.

Each of the challenges and synergies entails tensions. In both cases the **linkage draw the attention to choices** between competing values and alternative development paths that will need to be made. This is where politics has its place and policy maker can shape outcomes by framing discourse and creating the conditions for the identification of common ground and the formulation of compromises. As the discussion will show almost all the identified linkages span across different sectors and call for collaboration between established industries. It is here where cluster initiatives can play an active role, as will be discussed in the second part of this Section.

Smartness and/vs. resource consumption

'**Smartness'** – be it in form of smart design and manufacturing, 3D printing or smart logistics – implies the development, production and maintenance of a multitude of new equipment and of an infrastructure that provides for their interconnection. This in turn requires investment in new production and assembly lines and involves transportation. At the same time 'smartness' means that a wealth of new data will be gathered by the multitude of sensors that are going to be installed and by collating their signals, often without any prior purpose in mind.

The creation of smart systems and their interconnection has a **double impact** on resource efficiency. On the one hand, it requires additional resources and energy to manufacture all the new equipment and to put it into place. On the other, the availability of new type of data allows for novel analyses. Data mining will provide for the possibility to make the use of resources more efficient. For example, through self-tracking or the provision of personalised/company-specific data, actors – be it consumers of firms – can improve on their carbon footprint or other dimensions of resource use. In addition, the smartness of systems implies an instantaneous rollout and optimisation, once a more efficient use of resources has been identified. Finally, new products and services can be devised on the basis of the collected data.

Cluster initiatives represent a form of organisation that could balance the challenges and benefits of smartness in an economy. Within each cluster the cluster management will be in a strong position to convince companies and other cluster actors of the benefits of sharing information along the value chain, as they are trusted organisations. Cluster initiatives could conduct the analysis for an optimal use of resources and broker it among their members. Such a role would require additional expertise to identify those bits of data and information along the value chain that are of particular importance for the creation of new products and services and that enable cluster initiatives to conduct the necessary analyses and provide the required advice to companies.

Circular economy and data collection

'**Circular economy**' describes a system that keeps "the added value in products for as long as possible and eliminates waste. Resources are kept within the economy even after the end-of-life of a product, so that resources can be used productively again and can hence create further value"[54]. However, there are several regulatory challenges and conflicts between different activities of the circular econo-my. For instance, there is a conflict between the re-use and recycling: if reuse is pushed to strongly, then that would reduce the availability of materials for recycling, as a certain amount of recyclable materials is necessary to justify investments in and the maintenance of infrastructures for recycling.

Data gathered in smart systems will contribute to creating circular material flows, tracking material flows and to identify their volume and dynamic. Data from smart systems collected across complete value chain(s) will be necessary to judge the viability of business models for services and products that are designed, made and used according to the principles of a circular economy. At the same time there might arise a tension between the two specific scenarios, in that the smart systems themselves are not designed and manufactured to fit the requirements of a circular economy (see the discussion of subsequent tensions further below).

Cluster initiatives can play a central role to enable a circular economy, especially in their region(s), as the circularity is intimately linked to the value creation. Apart from collecting the necessary data, cluster management organisations can provide ideas for the reuse and recycling of products. The collected data will be the basis for taking decisions, whether reuse or recycling is the 'better' option (while 'good' and 'better' solutions need to be agreed upon through political processes). These decisions, if taken by various cluster practitioners together will require coordination and a facilitation of the decision-making process. Based on the analysis of the collected data, cluster management can advise the different organisations in the cluster about the viability of their (circular economy) business models.

[54] *COM/2014/0398 final*

Resilience vs. resource consumption

In the context of this study '**resilience'** can be understood as the ability of an organisational or technical system to maintain acceptable levels of services in face of external challenges or shocks. The ubiquity of smart systems and their interconnection implies an increased vulnerability of the actors and operations that depend on the function and seamless interplay of those systems.

One **strategy to ensure resilience** and the continued operation of systems in face of external shocks is the creation of (a number) of fall-back solutions, in case the original system fails or comes under attack. Creating back-ups requires resources. Hence, the team concludes that there is likely to be a tension between setting up resilient smart systems and resource efficiency.

Cluster initiatives can play a crucial role in ensuring resilience by identifying technical and organisational vulnerabilities along their value chains and addressing them with their organisations. Moreover, they can be instrumental to devise strategies of how to counter risks and to ensure resilience against external shocks or stress. The resilience concerns the particular sustainability and reliance of value chains, information and communications systems, as well as other infrastructures necessary for the production and service delivery in a cluster to continue under stress. Collaboration with other clusters that face complementary risks would be one option to make a cluster more resilient. The identification of risks and vulnerabilities that concern different clusters across Europe would require some coordination, a task could be taken up by European cluster policy makers.

Inclusiveness vs. resource consumption

'**Inclusiveness'** refers to the preconditions for different types of actors to participate in the smart world of 2025. Inclusiveness concerns actors foremost in their role as citizens and their participation in political decision-making but also in their role as consumers and entrepreneurs. Without appropriate access to information neither politics nor the economy – as they are envisioned here – can properly function.

The effort for the entire society to become more resource efficient would also be hampered if smart technologies and their application remain accessible only to some or to exclusive parts of the population, as the tackling of complex societal challenges requires a contribution from everyone. Inclusiveness impacts on resources efficiency in yet another way, namely that the equipment (e.g. the dashboards) and connection that need to be produced and made available will consume resources. In the case of electronic devices this will include the consumption of rare earths, which are particularly problematic in terms of carbon footprint and their impact on the environment.

Cluster initiatives, by their very nature, are inclusive for the partners within a cluster. Cluster organisations have plenty of expertise and instruments of how to share knowledge and resources among their members. They have skills and an extensive set of tools and instruments at their disposal to foster and deepen collaboration in a cluster. In addition and as the references to open innovation above have shown, for the future, cluster initiatives will need to extent their attention to other actors such as consumers and partners outside the cluster and draw them into specific collaboration activities.

Privacy and data security vs. ubiquitous and permanent data collection and mining

Both specific scenarios (implicitly) assume that a multitude of sensors will be installed, which will allow for gathering data in to an unprecedented extent. Data is the fuel of the economic, social and political life in 2025 as it is envisioned here. It allows for example for the self-optimisation with regard to resource use, as well as for smart services and products. It is further presumed that actors – be it business or individuals as citizens or consumers – will make ample use of the data provided to them. Only in this way can the scales be achieved that are necessary to have an impact sufficiently large to tackle the complex societal challenges.

'**Data security**' refers to the protection of data from destruction or from unwanted actions of unauthorised actors, 'privacy' means the protection of personal data and the control of access to them. Both touch upon the issues of trust and, thereby, upon a fundamental precondition for the interactions in society. While the former can be considered a of a 'management' challenge, where technical and organisational requirements can be clearly defined, the latter is related to personal and cultural values and much more difficult to operationalized.

The issue is of importance to clusters in a variety of ways. First, **cluster management organisation** need to be aware of any privacy and data security issues that might arise from the cooperation among their members. In addition, they would need to be sensitive to any issues that could arise along the value chain, extending outside the cluster, to avoid negative reactions of the supply or demand markets. Furthermore, as some of the new products and services are based on data that cuts across the market intelligence gathered by individual companies cluster organisations could have a role in fostering a consolidation or at least a reflection of market relevant data among their members. This data could e.g. concern consumer behaviour, as well as purchasing behaviour of firms or their resource-/climate-related performance. In any case it becomes clear, that those who will hold the data and have access to it, will also yield considerable power.

Codification of knowledge: standardisation vs. individualisation

The codification of knowledge comprises various activities that translate information, practical experience and expertise within authorised bodies of know how. Codified knowledge can take a number of forms ranging from guideline, codes of best practice and handbooks over standards to legislation. An entire industry – of conformity assessment and accreditation – has been developed around the activities of calibrating, measuring, controlling, testing and certifying, leading to a plethora of labels and certificates. There are numerous types of actors who codify knowledge such as craft and industry association, national, European and international standards organisations, or legislative bodies e.g. parliaments or governmental agencies. What they share is share the authority to declare a certain type of knowledge as binding, not necessarily legally binding but with some sort of normative power.

Both specific scenarios require the **continued codification** of knowledge as a precondition. Smartness will only be possible if systems are interoperable in terms of physical interfaces (e.g. the plug of the charger cable fits the car), data formats (e.g. charging station and car know what kind of date they need to exchange), communication (e.g. both devices understand each other), function (e.g. charging the car is combined with charging the account of the car owner), business model (e.g. interfaces for the interaction between car owner, car provider, financial service and utility) and legislation (e.g. liability is clearly assigned in case of a fire that damages the car). Similarly, a better use of resources requires recognised standards for measuring and categorising let's say emission levels or resources intensities. Clearly defined procedures, transparent labels and certificates ensuring to comparable results are a precondition for guiding purchasing and procurement decisions of consumers and companies respectively, as well as their monitoring and the self-management.

The formulation of the standards underlying interoperability and facilitating measurement and labelling will require cross-sectoral collaboration. **Cluster initiatives** have ample experience in managing interdisciplinary teams and aligning them around a shared purpose. They will continue to play a central role in knowledge management and learning. Cluster initiatives will need to embrace new forms of learning including the sourcing of novel expertise from outside the cluster, the translation or combination of different bodies knowledge, when collaborating with other clusters or incorporating companies from new sectors. Cross-cluster cooperation will help to further spread good practices, as it is done already through the Executive Agency for Small and Medium-sized Enterprises (EASME). In addition, cluster initiatives could become active in standardisation activities and consult clusters in other regions of Europe.

Based on these reflections about the linkage between the inductive scenarios of the world in 2025, as well as all other results of the foresight exercise, the team has drawn several conclusions and policy recommendations, which will be presented in the next chapter.

5. Conclusions and policy recommendations

Based on the analysis of our different data streams and the scenarios built in the foresight exercise of the project, this chapter presents conclusions and policy recommendations. They refer to policy makers and, where possible, also to cluster initiatives and cluster actors. The conclusions and recommendations relate to four main topics. The foresight team recommends:

- To turn the challenge of increasing complexity into an opportunity by pushing towards economic complexity.
- To turn clusters into forerunners of economic and societal developments that later occur in other parts of the economy.
- To strengthen the regional dimension as a starting point for cross-sectoral and cross-cluster policy,
- To support clusters in their multiple roles to manage the regional knowledge economy.

To actively turn a challenge into an opportunity by pushing towards economic complexity

The foresight exercise yielded a **novel conceptual perspective** on cross-sectoral and cross-cluster collaboration as means of seizing the opportunities of economic complexity. Complexity is usually considered to be an issue that is better avoided than met, i.e. there is a general tendency trying to reduce complexity. However, today's world is complex and the social, economic and political challenges require solutions that account for and adapt to this complexity rather than try to control it. Policy sets out to tackle complex challenges such as climate change or demographic change and the technological solutions used to address them are in themselves complex. Complex solutions include elaborated adaptive and flexible organisational, technological and regulatory systems.

It is an enormous **opportunity for European industry** and economies to understand complexity as an opportunity to generate robust competitive advantages. Circumstances like the large variety and differences of European countries and regions, that have been seen as a hurdle for innovation in the past (due to the lack of harmonisation and streamlining), can now be turned into a valuable resource for innovation. The ability not only to handle complexity but to generate **„complex solutions for a complex world"** will be a key driver for Europe's competitiveness. The inter- and transdisciplinary collaboration – a phenomenon that has been observed in science and research as a strategy to respond to complex research questions – is spilling-over into the realm of innovation. Consequently, industrial cross-activities can be seen in an analogy to academic forms of collaboration.

Cross-sectoral and cross-cluster collaboration can be understood as ways of building and maintaining competitive advantages or even competitive exclusiveness in a **complex environment**. They combine in novel and flexible ways to bring together and to coordinate a wide range of heterogeneous actors, who in combination can address today's complex challenges. In light of the fact that established processes and structures become more permeable and flexible value creation, especially in a knowledge economy, increasingly takes place outside clearly identifiable sectors and industries. Consequently, the capability of clusters to manage processes across such dissolving boundaries becomes a key success factor.

Policy makers should find means to encourage companies and cluster organisations to seize the opportunities linked to the creation of complex products and services. What is required is less a focus on particular technologies and their development but rather more consideration of the cultural and social aspects of innovation. In addition, policy makers should seek ways to support cluster actors to increase their spectrum of technical capabilities and know how, the diversification of their product range and to collaborate with counterparts from other sectors. To this end, adjustments at the level of

policy framing, as well as individual policy instruments and programmes seem to be required. For example, an even stronger emphasis would need to be put on the framing of challenges and problems, while leaving the ways in which the challenges are to be addressed open to actors from industry, science, and society. The collaboration of diverse sets of actors, crossing scientific disciplines and different sectors would need to be encouraged more than in the past. Grant schemes with their award criteria would need to be broader in scope to foster research and innovation at the interface and on the convergence of different technologies rather than single technologies.

Similarly, **cluster initiatives** should make the actors in their networks aware of the opportunities related to embracing complexity. Foresight exercises run by one or several clusters about the opportunities stemming from a possible combination of their strength would be one way to achieve this end. Foresight and roadmapping are tools that can serve not only to identify new business and development prospects and to discuss related risks and chances but also to forge a common vision among the actors of a cluster. Therefore, cluster initiative should regularly run such foresight and roadmapping exercises.

To make clusters to forerunners of developments that later occur in other parts of the economy

The foresight exercise found evidence that the traditional understanding of cluster initiatives as means for **regional development** is at times reversed and clusters actively shape their regions including the partnering and collaboration strategies of their regions.

In some respects clusters have become microcosms of their surrounding environment. Rather than merely considering the region as an eco-system in which a cluster is formed, **clusters can actively shape regional strategies** of development and (international) cooperation. They can place themselves at the heart of the development of smart specialisation strategies for their regions and drive the efforts to link the region into international value chains and to place it on the international innovation map. Thereby, cluster can serve as laboratories and incubators for future policies concerning economic cooperation structures and smart regions. In this context clusters can be regarded as 'horizontal enablers' of government policy. Instead of only being a subject of regional development policy, clusters could actively pursue economic policy in domains such as ICT, Healthcare, Biotech and creative industries.

Cluster policy should consider ways to encourage regional governments to experiment with their clusters as an engine for regional partnering and international cooperation. The effects of cross-sectoral and cross-cluster cooperation should be thoroughly analysed with regard to their significance for the entire economy. Policy instruments used to promote innovation in clusters should be considered for a wider application in other contexts.

Cluster initiatives should promote the awareness among cluster actors and among regional policy makers about the chances that a successful cluster development entails for the development of the region and the benefits it may yield for actors beyond the cluster. Moreover, they should seek to shape regional policy making as whole, i.e. not only the economic dimension, to the advantage of the cluster. For example, while cluster initiatives might already be involved in educational policy at the level of professional training and higher education, they could also contribute to raising the profile of particular subject in schools and pre-school settings. Similarly, international partnering of cities or regions could provide 'political cover' for closer cooperation between clusters in different countries.

To strengthen the regional dimension as a starting point for cross-sectoral and cross-cluster policy

The foresight exercise of the European Cluster Observatory concludes that the regional dimension is of particular importance for the emergence and success of cross-sectoral and cross-cluster activities.

The team therefore suggests to strengthen the regional dimension as a starting point for cross-sectoral and cross-cluster policy instead of initially looking for pan-European collaboration. Even if it is not excluded that, for example, a machinery cluster from Italy could cooperate with a bio-tech cluster from Ireland in order to jointly improve economic performance and competitiveness, it seems to be much more likely that different clusters / sectors located **in the same region** will work together in order to benefit from cross-effects.

This finding is fully **in line with two trends**: on the one hand, with the development of new clusters, where the close geographic relation is generally a key factor. This logic seems to be repeated when it comes to collaboration between clusters in order to generate and use synergies. Even if mature clusters tend to complement their missing competencies in a more pan-European or international way (approaching new markets, integrating new techniques and methods within the range of their main business model), the initial cross-sectoral/cross-cluster settings seem to be more region-oriented. This conclusion is well in line with a generally observed tendency of a renaissance of the regions: as a common resource, identity („way to think“) and „innovative milieu“. On the other hand, this finding is supported by a fact repeatedly identified in the foresight exercise: a strong regional identity and a care for the wellbeing of the immediate environment in which people live is regarded as an important demand-side driven trend. It is for their region that people are ready to take action, to get involved, to share their creativity (or to pay a premium). It is also regional sources that people tend to trust and where to seek solutions for the issues at hand.

Consequently, **cluster policy** needs to be sensitive to the local context, as well as to the timing of its intervention. For European cluster policy this implies to focus on incentives for regional policy to take up the initiative and on building the collaboration necessary for addressing complex and dynamic challenges. Before trying to set up a pan-European network fostering cross-sectoral and cross-cluster potentials, it seems to be more promising to support local/regional activities aiming at realising cross-benefits. Regional and local policy makers should support the exploration of synergies that regional cross-cluster cooperation might yield. Activities such as explorative studies, joint visioning workshops with different cluster initiatives as participants including the discussion and transfer of lessons learned elsewhere could be ways for local and regional policy makers to explore possible synergies. At EU level cluster policy should focus on the support of cross-cluster cooperation that involves several countries and regions to avoid that clusters, as well as (regional and national) cluster policy gets logged into too narrow perspectives, preventing to yield European synergies. Moreover, cluster policy should promote the wide-ranging identification of good practices and their effective dissemination. The European Cluster Observatory might serve as an example of such a measure.

Cluster initiatives could strengthen the regional dimension in two ways: first, by collecting the data necessary to show the regional impact of their cluster(s), as well as the importance that the region might have for the cluster(s) to flourish. The access to talent and the role of education at all stages of life – pre-school, primary, secondary and tertiary education – has already been mentioned. To tap on possible other resources in a region, cluster initiatives could also explore the future development together with unlikely partners that are active in the region such as young entrepreneurs, non-governmental organisations or (regional) citizen associations.

To support clusters initiatives in their multiple roles to manage the regional knowledge economy

The foresight exercise leads to the conclusion that clusters are well-placed to play a key role as managers of the regional **knowledge economy**. Hence, the foresight team proposes to support clusters in their multiple roles to manage the regional knowledge economy, taking advantage of recombining useful knowledge, which will also serve as an enabling condition for economic complexity.

The creation, sharing and application of new information and of knowledge is based on trust. The future will see the collection, processing and provision of large amount of data. The data will be collected by an increasing number of digital sensors that gather facts about the environment, individual behaviour, organisational processes and interactions. It will be provided in real-time to be aggregated by larger systems at different levels according to the ever-evolving needs of different communities. Whether companies, citizens or consumers will be the users of information, they will need to trust in the quality, reliability and integrity of the information provided to them. In light of a shift in values towards an increasing importance of regions and given their regional roots, clusters are well placed to provide that trust and inject the necessary lubricant for the workings of a regional knowledge economy.

In particular, the foresight exercise – emphasising issues of 'smartness' and 'resource efficiency' – suggests that cluster initiatives could play a crucial role with regard to the following functions related to knowledge management and networking:

- **Identification of cross-cutting risks along the value chain:** A number of risks that might arise in the future were identified at the linkages between the two specific scenarios of the baseline scenario in 2025 ('smartness' and 'resource efficiency'). They concern e.g. privacy and security of data and the resilience of organisational, technical and social systems. Cluster management organisations are well placed to increase the sensitivity of companies and researchers towards such issues, to identify these risks along the value chains and to address them in and beyond their own clusters.
- **Identification of cross-cutting opportunities along the value chain:** By the same token, cluster initiatives can contribute to seizing the opportunities arising from the wealth of new data and the need to address challenges such as resource efficiency. The construction of a circular economy or of 'industrial symbiosis', where the waste of one firm becomes the input for another company, takes place in a regional ecological innovation system, as it is here where trust among actors can assumed to be larger and cost to create transparency lower in comparison to value chains spanning the entire globe. Moreover, transportation across long distance, as mentioned above will not climate neutral yet. By implication it is regional value chains that need to by analysed and improved. The related activities can be done by individual clusters but can also be subject of cross-cluster collaboration. They involve activities such as the provision of information about regional value chains and ways to improve their performance or the coordination of production and consumption processes along them. In other words, "climate/resource performance management" could become a central cluster task. To take up these tasks, cluster initiatives would need to add skills and expertise to their portfolio. The potential to seize cross-cutting opportunities along the value chain can be increased, if the analysis and management is extended through cross-sectoral and cross-cluster collaboration. Here cluster policy makers could support clusters by raising the awareness about and endorsing the need to think beyond the borders of clusters.
- **Codifying and sharing knowledge:** Cluster actors will need to embrace new forms of learning including the sourcing of novel expertise from outside the cluster, the translation or combination of different bodies knowledge, when collaborating with other clusters or incorporating companies from new sectors. Cross-cluster cooperation will help to further spread good practices, as it is done already through the Executive Agency for Small and Medium-sized Enterprises (EASME). In addition, they could become active in standardisation activities and consult clusters in other regions of Europe.
- E**ducation, training and continuous learning:** Finally, clusters are likely to play a central role in education, training and continuous learning in their region. They could collaborate closely along the education "value chain" starting with the pre-school organisations and

schools, over the organisations offering apprenticeship and university education to public and private training organisation, ensuring lifelong learning. Organising the training for their companies in joint facilities will allow clusters to benefit from scale effects and lower the search cost for the participating companies. Part of cross-clustering among different regions might be to ensure the mobility of young adults seeking an education or vocational training in a region with little opportunities in one field and guiding them to learn in a region with a demand for young people. To this end, cluster management will need to make the actors in their network aware of the benefits of continuous learning and training, a task, which requires a long-term effort. Communication and awareness raising among cluster actors would require that cluster policy not only supports the development of skills of the cluster management but also provides means to coach cluster actors.

In sum, cluster initiatives operating at regional level are a prime locus to tap into the variety of sources for innovation in each region including SMEs, transnational corporations and research organisations, as well as citizens and consumers. Cluster policy should support cluster organisations to assume the roles related to an active management of these knowledge resources. A **systematic and long-term effort** is required to foster the role of cluster initiatives in the regional knowledge economy. For the benefits of the recommended measures to affect value chains and to trickle down to cluster actors, as well as to the regions policy instruments and funding programmes at different levels would need to be adjusted. This hold in particular for the collaboration among clusters spanning different regions or countries. The effects of such a policy would need to be regularly monitored and fed back into the decision-making process to ensure for it to have an impact.

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Appendix A: Trends identified by ESPAS

The following brief description of an foresight analysis prepared by the European Strategy and Policy Analysis (ESPAS)[55]. As merely one example of other foresight exercises examined for the purpose of this study, it is presented here to illustrate how close the identified trends are to each other.

In 2015 ESPAS identified five key global trends of **particular importance for the European Union** in the period until 2030, [56] which also fit in the scheme of mega trends as shown in Table 1.

1. A richer and older human race characterised by an expanding global middle class and greater inequalities (which can be related to "demographic change" and "social disparities" in the table above)
2. A more vulnerable globalisation led by an 'economic G3' (relating to "a new world order", "globalisation 2.0" and "global risk society")
3. A transformative industrial and technological revolution (relating to "From Forced Technology to High Tech/High Touch" and the majority of the "industrial megatrends")
4. A growing nexus of climate change, energy and competition for resources (relating to "Upheavals in Energy and Resources", "Climate Change and Environmental Impacts", "Carbon foot-print reduction" and "from north to south")
5. Changing power, interdependence and fragile multilaterism (relating to "a new world order, "global risk society", "From Either/Or to Multiple Options", "Social and Cultural Disparities" in the table above)

For the purpose of this report, trends 3 and 4 might be of special importance as they can be expected to have direct repercussions on clusters. For trend number 3 the ESPAS present the following projections:

- *new industrial production, bio-scientific, communication and digital processes will be the basis of a technological revolution*
- accelerating speed of technological change
- *rapid rise in autonomous decision-making processes*
- science and knowledge creation will continue to be led by the US and Europe, however concerns about applied research persist

In relation to these projections, the digitalisation of world markets, the possibility of a third industrial revolution through the convergence of several future technological leaps as well as the anticipation of coming technological breakthroughs, such as the 'Internet of Things', ubiquitous sensors, big data, 3D

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[55] *The ESPAS was launched as a Pilot Project and subsequently became a Preparatory Action under the 2010 and 2012 European Union budgets respectively (ESPAS 2015). In this activity, representatives of the European Commission, the European Parliament, the General Secretariat of the Council of the European Union and the European External Action Service cooperate to analyse global trends.*

[56] *European Strategy and Policy Analysis System (ESPAS) (2015), 2030 Global Trends to 2030: Can the EU meet the challenges ahead? Available at http://espas.eu/orbis/sites/default/files/generated/document/en/espas-report-2015_0.pdf.*

printing, intelligent mobility; new models of mobility (‚the emerging mobility revolution') are topics which received increased attention.

The key global trend 4 – a growing nexus of climate change, energy and competition for resources is based on the following projections:

- *Concentration of large-scale exploitation of natural resources in a small number of dominant regions and countries*
- *Scarcity will be the central topic in terms of food and water supply management and will be increased by the effects of climate change*
- By 2030, 93% of global energy demand rise will stem from non-OECD countries

Among the topics discussed in more detail are a rising energy consumption in the future and its supply structures as well as rivalries in the Artic zone due to its natural resources and shipping routes.

Foresight studies conducted by several national ministries arrive at similar results. For example, the German Federal Ministry of Education and Research (BMBF) commissioned a foresight and they highlight the following **societal challenges by 2030**:

- *Learning and working in a smart world of digitalisation and autonomous computer systems*
- *New drivers and actors in the global competition for innovation – between global developments and regions as innovation laboratories*
- *New dimensions of growth and the balance between sustainability, affluence and quality of life*
- *New challenges concerning transparency, post-privacy and privacy protection*
- Citizens will become active agents in the research and innovation system
- New governance for new challenges – from the global laboratory 'city' to new forms of multilateral cooperation
- Plural societies in search of belonging and distinction

These challenges are detailed by a large set of 60 societal trend. The latter include Trust in the Era of the Internet, Post-Privacy vs Protection of Privacy, Cyber-Physical Systems – Between Development and Control, Gamification – Persuasive Games in increasing Areas of Life, A New Culture of Sharing or Personal Footprint – more Responsible Consumption.[57]

[57] *VDI TZ, Fraunhofer ISI (2014), BMBF-Foresight-Zyklus II Suchphase 2012-2014, Zwischenergebnis 2 – Gesellschaftliche Herausforderungen 2030. Available at* http://www.bmbf.de/pubRD/bmbf_foresight_gesellschaftliche_herausforderungen.pdf

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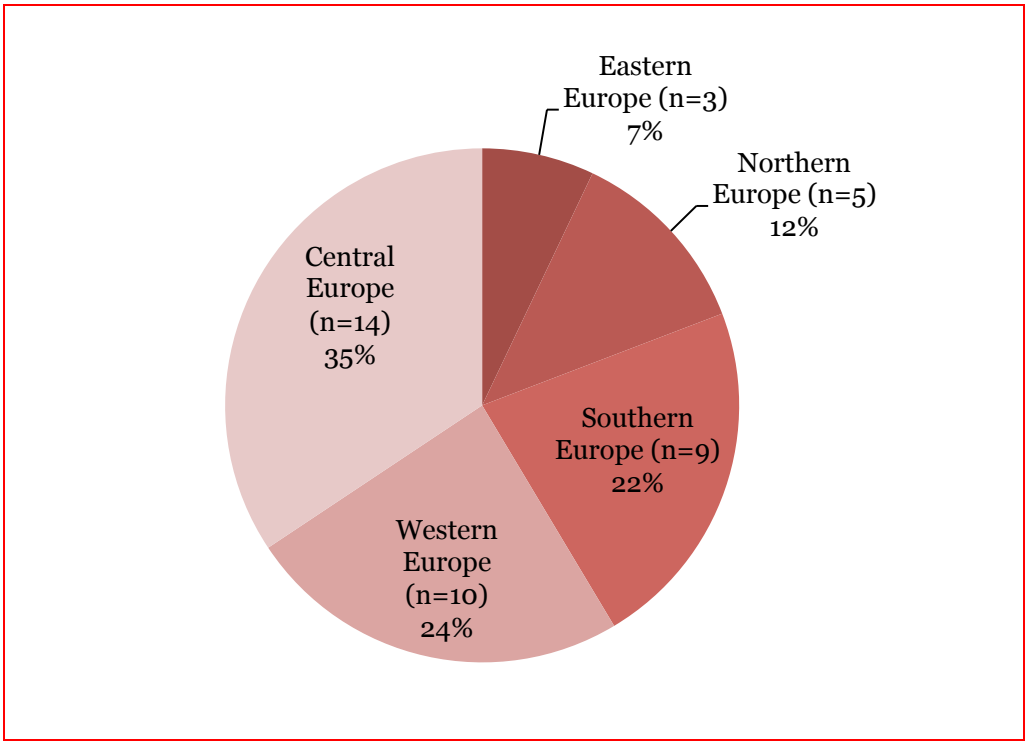
Appendix B: Survey among cluster managers

The appendix contains selected results from a survey conducted among cluster managers in November 2014. The project team surveyed managers of excellence clusters from across Europe, representing 120 of the most active and well-established cluster initiatives that were benchmarked by the European Secretariat for Cluster Analysis (ESCA). All in all the team received 42 responses.

1. Characteristics of Survey participants

Most respondents who answered the survey were managers of clusters located in Central, Western and Southern Europe. They made up more than 80 % of all respondents. No survey respondent is part of a cluster from out of Europe. Figure 6 shows the regional distribution of survey respondents. The information is based on a self-assessment of respondents.

Figure 6: Regional distribution of survey respondents (n=41)



Source: Technopolis Group and VDI/VDE-IT

The following table shows the sectoral distribution of survey participants. About a third of all survey participants represent a cluster from the IT sector. This overrepresentation in this study should be kept in mind when reading the further analysis. No participants from the Finance & Insurance, Food, Packaging or Marine sectors took part in the survey, which is why these sectors are omitted in the subsequent analyses.

Table 2: Sectoral distribution of survey respondents (n=39)

Sector	Responses (%)	Total (#)
IT (Hardware & Software plus related services)	33.3 %	13
Biotechnology	18 %	7
Renewable resources	15.4 %	6
Health & Wellbeing (pharma, medicine, medical technology, diagnostics/analytics, etc.)	12.8 %	5
New materials	12.8 %	5
Mobility & logistics (automotive, railway, transportation, navigation, etc.)	12.8 %	5
Production & Engineering (Manufacturing, intralogistics, cyber-physical systems etc.)	10.3 %	4
Micro-Nano-Opto	7.7 %	3
Environment	7.7 %	3
Chemistry	7.7 %	3
Energy	7.7 %	3
Construction (Housing, buildings, infrastructure etc.)	7.7 %	3
Creative industries, culture & media	5.1 %	2
Mining & Resources / Primary Industry	2.6 %	1
Air & Space (planes, satellites)	2.6 %	1
Finance & Insurance	-	-
Food (agriculture, food processing etc.)	-	-
Packaging	-	-
Marine (ships, harbours, fishing/aqua culture, deep sea)	-	-

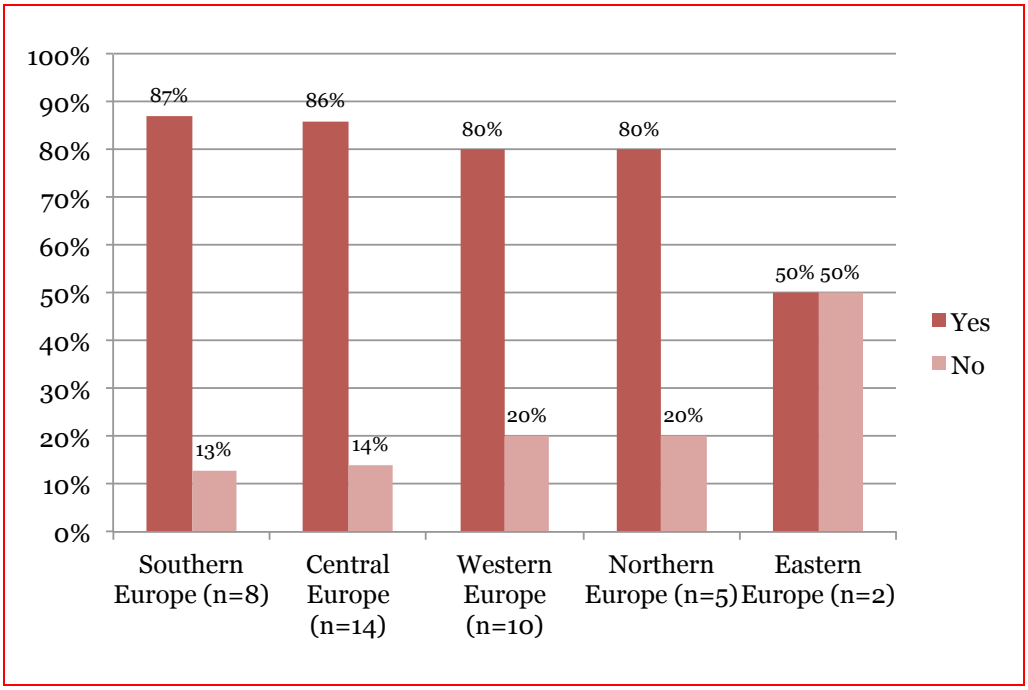
2. Awareness of cross-clustering

Independent of their sectoral and regional distribution, 83 % of survey respondents (n=40) are aware of any examples of cross-clustering, while 17 % are not.

By region

As shown in Figure 7, the regional distribution of the relative awareness of examples for cross-clustering is, with the exception of Eastern Europe, relatively even. In most of the European regions, the majority of cluster managers are aware of cross-clustering.

Figure 7: Awareness of examples for cross-clustering, by region

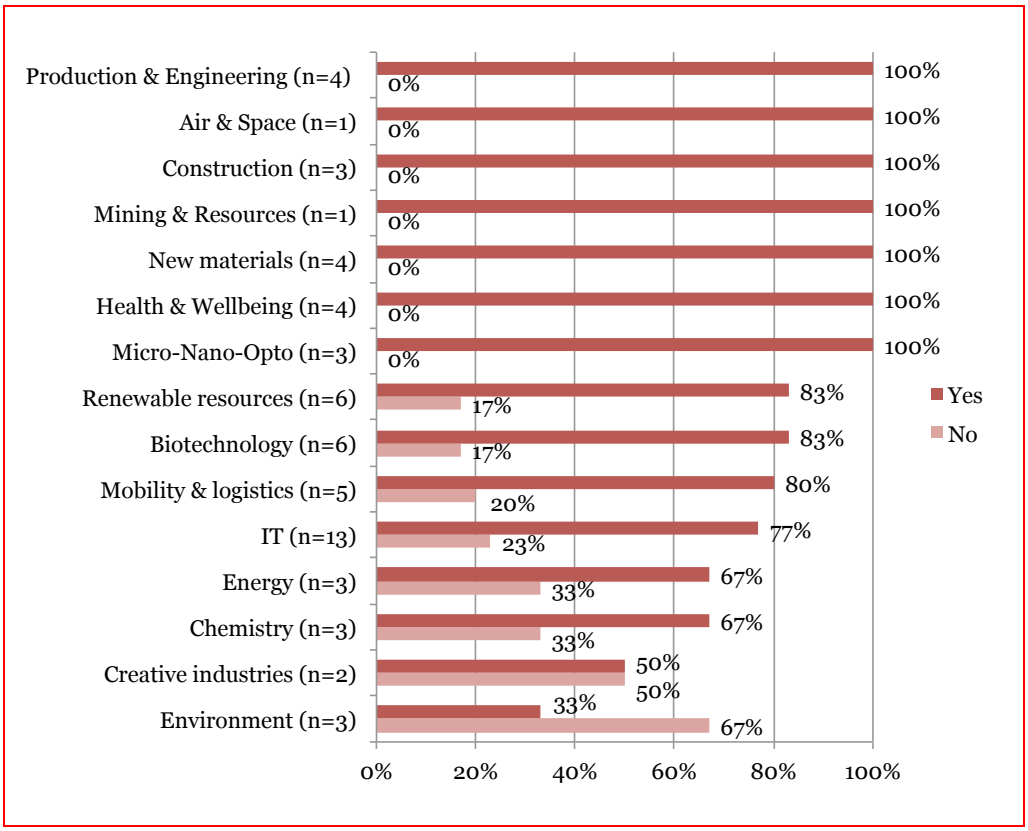


Source: Technopolis Group and VDI/VDE-IT

By sector

Figure 8 provides an overview of the relative awareness of examples for cross-clustering per sector. On average, at least 50 % of cluster managers are aware of examples for cross-clustering across all sectors, except for the Environment sector, where only one out of three cluster managers is aware of examples for cross-clustering. In the IT sector, more than two thirds of cluster managers are aware of cross-clustering.

Figure 8: Awareness of examples for cross-clustering, by sector



Source: Technopolis Group and VDI/VDE-IT

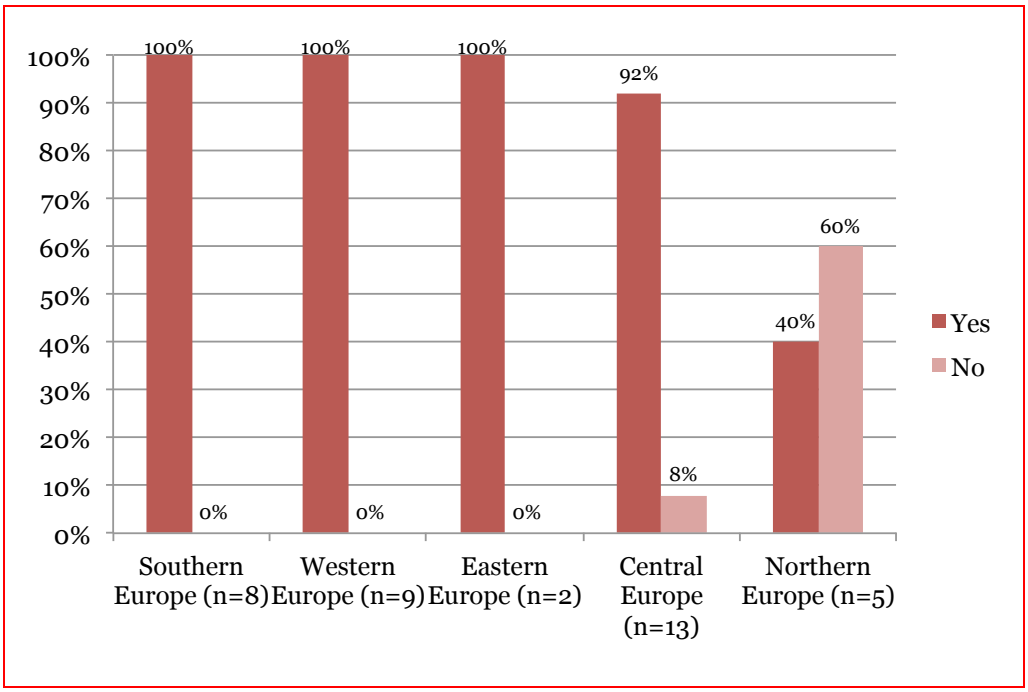
3. Significance of cross-clustering for future cluster development

Independent of their sectoral and regional distribution, 90 % of survey respondents (n=38) think that cross-clustering is important for future cluster development, while 10 % do not.

By Region

Figure 9 provides an overview of the survey respondents' assessment of importance of cross-clustering for future cluster development for every region surveyed. With the exception of Northern Europe, cluster managers from almost every region think that cross-clustering is important for future cluster development.

Figure 9: Assessment of importance of cross-clustering for future cluster development, by region

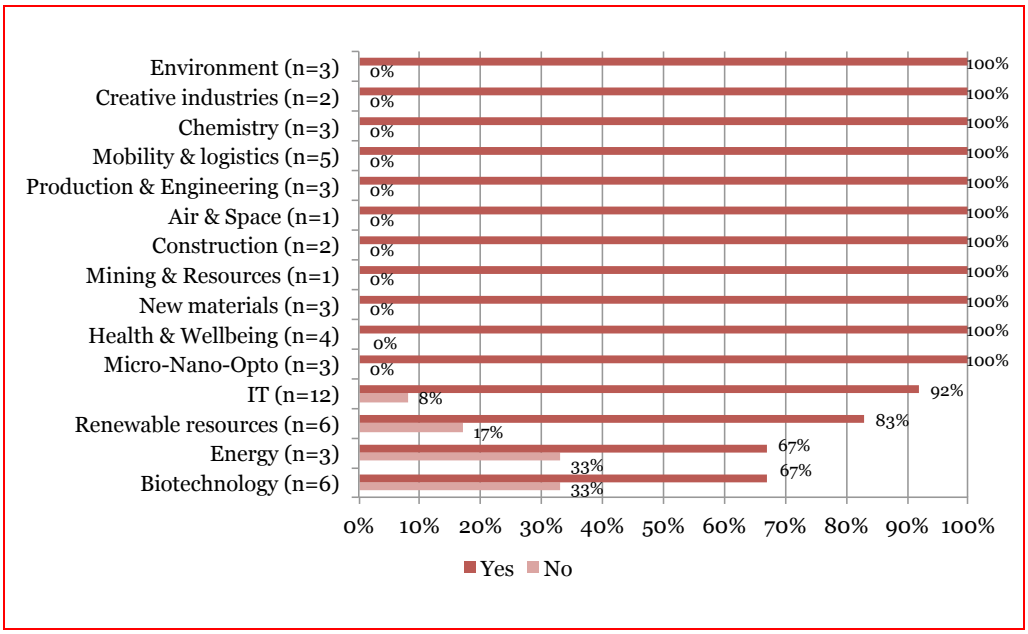


Source: Technopolis Group and VDI/VDE-IT

By Sector

Figure 10 provides an overview of the cluster managers' different assessments of importance of cross-clustering for future cluster development for all sectors surveyed. Across all sectors, the majority of cluster managers think that cross-clustering is important for future cluster development. This feeling is less accentuated in the Energy and Biotechnology sectors, albeit still high with about two thirds believing cross-clustering is of importance for future cluster development.

Figure 10: Assessment of importance of cross-clustering for future cluster development, by sector



Source: Technopolis Group and VDI/VDE-IT

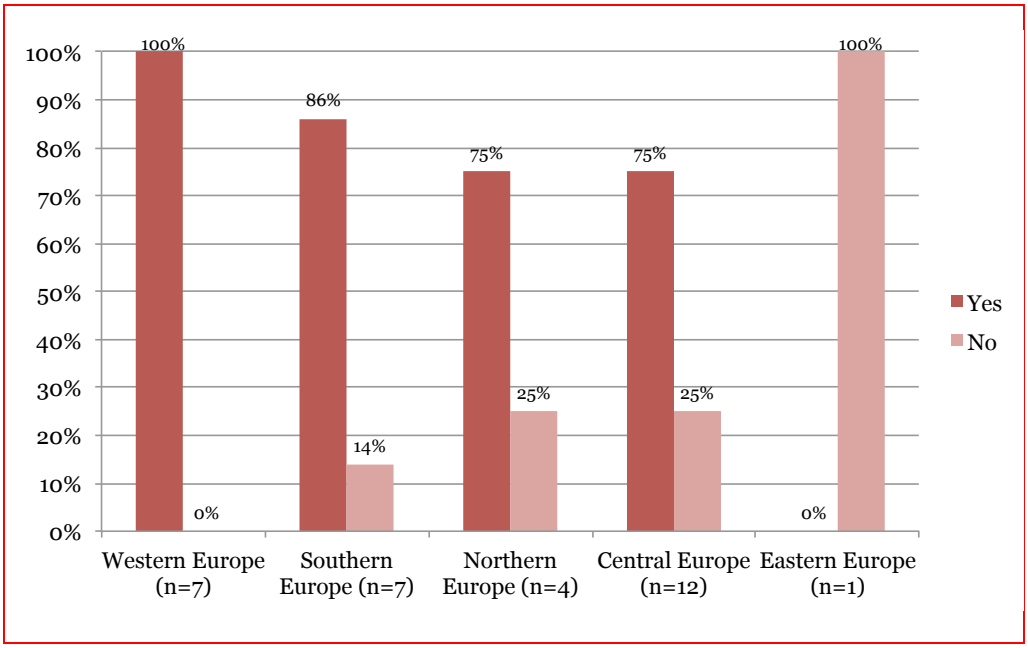
4. On cross-clustering strategies

Independent of their sectoral and regional distribution, 81 % of survey respondents (n=32) state that their cluster pursues a cross-clustering strategy, while 19 % are not.

By Region

Figure 11 provides an overview of the rates of pursuance of cross-clustering strategies for every region surveyed. The diagram shows that cross-clustering strategies are most frequent in Western and Southern Europe. However, in Northern and Central Europe, still three out of four clusters are pursuing a cross-clustering strategy. The only respondent to this question from a cluster in Eastern Europe states they are not pursuing a cross-clustering strategy.

Figure 11: Pursuing a cross-clustering strategy, by region

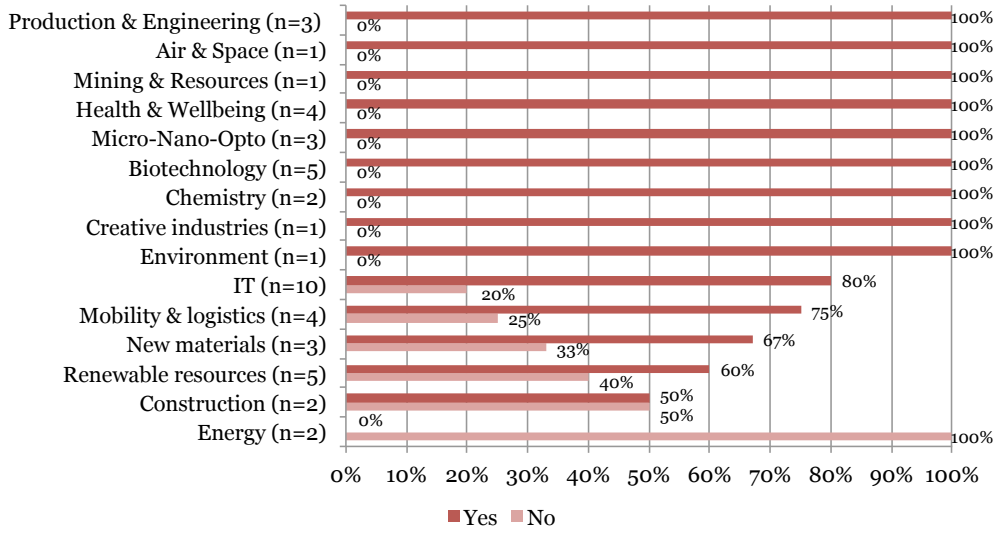


Source: Technopolis Group and VDI/VDE-IT

By Sector

Figure 12 provides an overview of the rates of pursuance of cross-clustering strategies for every sector surveyed. Cluster managers from most of the sectors included in this survey state that their cluster pursues a cross-clustering strategy. Only cluster managers from the Energy sector report consistently no pursuance of a cross-clustering strategy.

Figure 12: Pursuance of a cross-clustering strategy, by sector

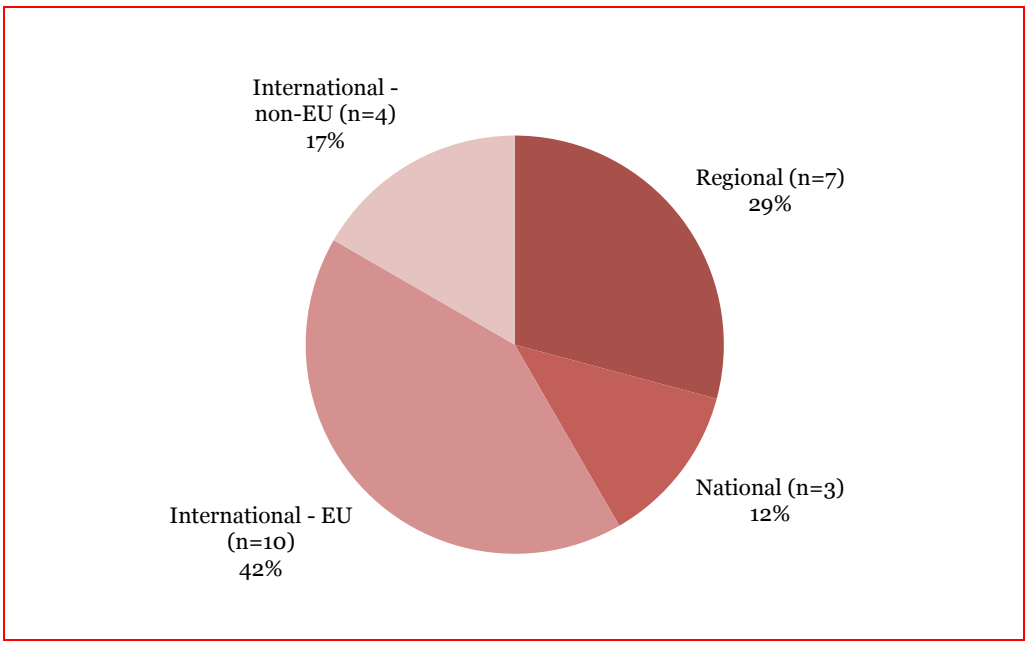


Source: Technopolis Group and VDI/VDE-IT

5. Geographic dimension of the cross-clustering strategy

Of the 32 respondents who pursue a cross-clustering strategy, 75 % specified the geographic dimension of the strategy, as shown by Figure 13. The majority of cluster managers see the geographic dimension of their cross-clustering strategy in the international sphere. The EU countries, however, dominate the international geographic dimension with 42 %, versus 17 % of cross-clustering strategies aiming at the non-EU-level. About 40 % of cross-clustering strategies aim at either the regional or national sphere.

Figure 13: Geographic dimension of the cross-clustering strategy



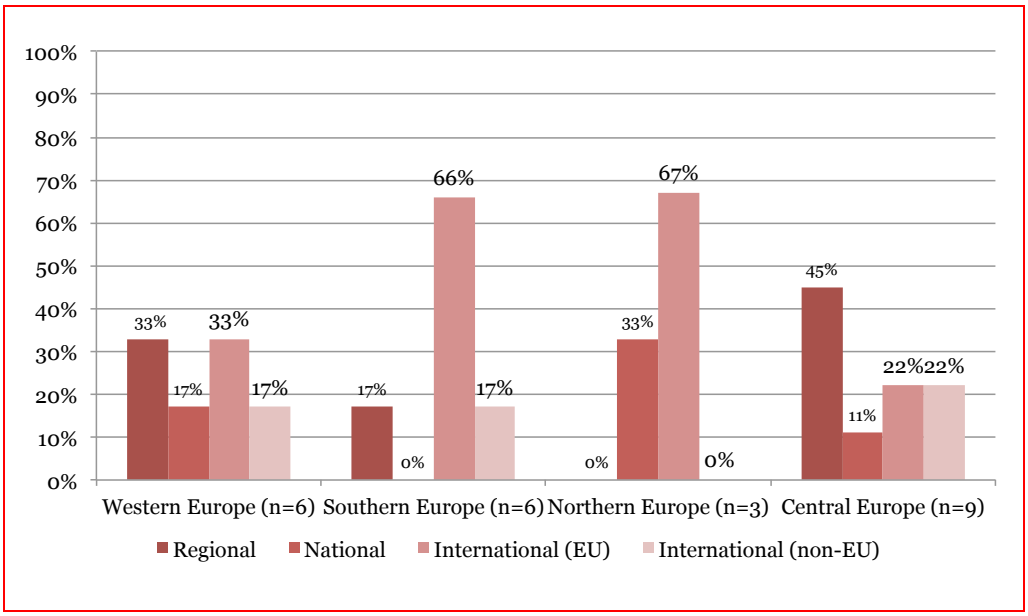
Source: Technopolis/VDI-VDE IT

5.1.1.1 By Region

Figure 14 provides an overview of the geographic dimension of the cross-clustering strategies for every region surveyed.

- Whereas in Western Europe the distribution of geographic dimensions of the cross-clustering strategies is quite evenly shaped,
- in Northern and Southern Europe the International (EU) dimension clearly dominates the strategies of clusters.
- In Central Europe the regional dimension represents the most frequent geographic dimension of cross-clustering strategies.
- There were no responses from clusters surveyed from Eastern Europe.

Figure 14: Geographic dimension of the cross-clustering strategy, by region



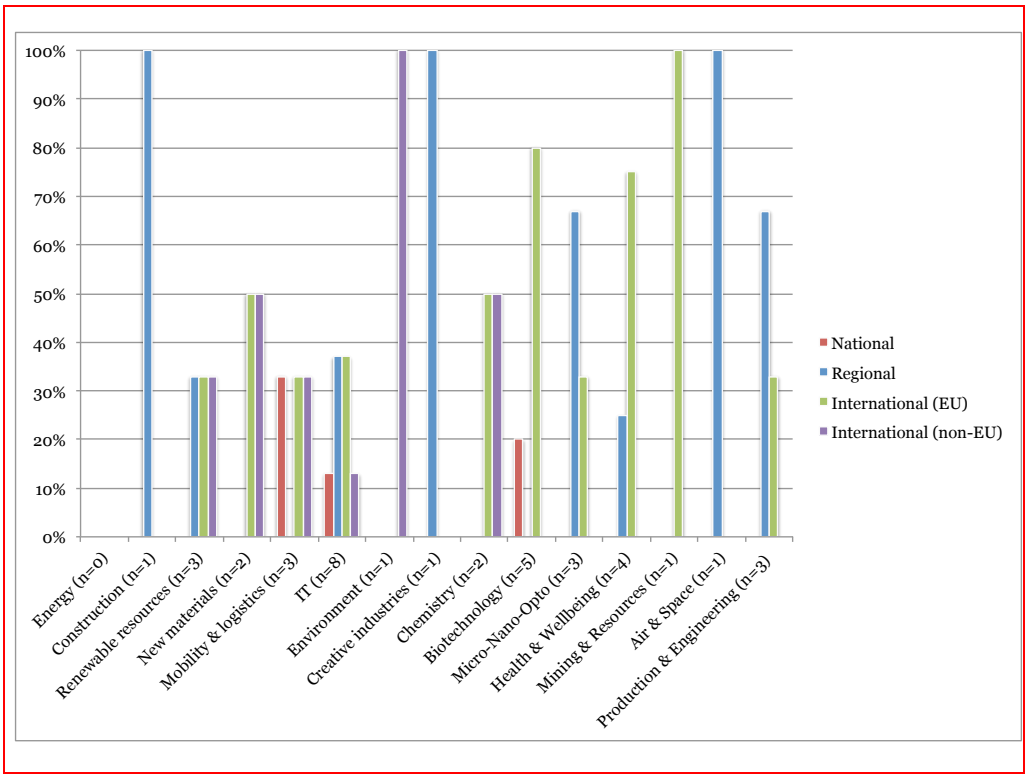
Source: Technopolis/VDI-VDE IT

By Sector

Figure 15 provides an overview of the geographic dimension of the cross-clustering strategies for every sector surveyed. The distribution of the geographic dimension of the cross-clustering strategy varies significantly across all sectors surveyed.

Whereas the IT sector exhibits a focus of the geographic dimension on the Regional and International (EU) realm (about 40 %, respectively), both clusters from the Biotechnology and Health & Wellbeing sectors strongly target the International (EU) dimension (about 80 %).

Figure 15: Geographic dimension of the cross-clustering strategy, by sector



Source: Technopolis Group and VDI/VDE-IT

Appendix C: List of participants of the Expert Foresight Workshop

Austria	Christian Altmann	Clusterland Oberösterreich
Austria	Tobias Schwab	EcoWorldStyria
Bulgaria	Silvia Stumpf	Varna Tourist Cluster
Bulgaria	Velizar Valkov	JAR Ltd
Czech Republic	Břetislav Skácel	CREA Hydro&Energy
Denmark	Per Spindler	BioPeople
Denmark	Morten Solgaard Thomsen	Ministry of Higher Education and Science
France	Philippe Roy	Cap Digital
France	Isabelle Riviere- Cazaux	LUTB Transport & Mobility Systems Rhône-Alpes Automotive Cluster
Germany	Jörg Günther	Kunststoff-Institut Lüdenscheid GmbH
Germany	Frank Bösemberg	Silicon Saxony
Germany	Akuma Saningong	EurA Consult AG - Niederlassung Nord
Greece	Nektaria Berikou	Corallia
Hungary	Barnabas Malnay	Hungarian Mobility and Multimedia Cluster
Netherlands	Willem Koeman	Amsterdam Economic Board
Netherlands	Patrick van der Duin	Technical University of Delft
Portugal	Gabriel Pestana	INOV Inesc Inovação
Romania	Cornelia Muraru-Ionel	IndAgroPol cluster
Romania	Costin Lianu	Coordinator National Export Strategy
Serbia	Igor Vijatov	Serbian Automotive Cluster
Spain	Enric Pedrós Beyà	FEMAC.CAT The Cluster of Agricultural Machinery
Sweden	Johan P Bång	Managing Director - Future Position X
United Kingdom	David Furmage	Cluster 2020

For further information, please consult the European Cluster Observatory Website:

http://ec.europa.eu/growth/smes/cluster/observatory/

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