POLICY-LENSING OF RESEARCH AND INNOVATION SYSTEM SCENARIOS: A DEMONSTRATION FOR THE EUROPEAN RESEARCH AREA

Douglas K.R. ROBINSON[1,2], Antoine SCHOEN[1], Philippe LAREDO[1,3], Jordi MOLAS GALLART[4], Philine WARNKE[5], Stefan KUHLMANN[6], Gonzalo ORDONEZ MATAMOROS[6,7]

[1] **Université Paris-Est Marne-la-Vallée, LATTS, IFRIS, Paris, France, Email: douglas.robinson@teqnode.com**

[2] **TEQNODE Ltd, 282 rue Saint Jacques, 75005 Paris, France.**

[3] **Manchester Business School, The University of Manchester, Booth St W, Manchester M15 6PB, UK**

[4] **INGENIO, CSIC-UPV, Polytechnic University of Valencia, Camini de Vera s/n, 46007 Valencia, Spain**

[5] **Fraunhofer Institute for Systems and Innovation Research ISI, Breslauer Strasse 48, 76139 Karlsruhe**

[6] **Science, Technology, and Policy Studies (STəPS), University of Twente, Enschede, the Netherlands**

[7] **Facultad de Finanzas, Gobierno y Relaciones Internacionales. Universidad Externado de Colombia, Colombia**

Abstract

In this paper we present 'Policy Lensing' of future scenarios as an analytical step in its own right and as a genuine activity in the elaboration of strategic policy intelligence. The previous four FTA seminars have revealed a wealth of tools, techniques and applications of FTA for forecasting science and technology developments, up to and including technology transitions. As STI policy scholars and professional analysts, we are interested in applying FTA to inform policy shapers about the future research and innovation landscape. What we have realised is that translating the often very rich and complex outputs of FTA into policy relevant intelligence is not a negligible step. In fact, we have found the literature rather lacking in this regard. Over a 12-month period, the EC FP7 funded project entitled Visions of the European Research Area (VERA) has, through a systematic exploration and interaction with experts, developed four scenarios of the European research and innovation system in 2030.

The challenge we faced, once these scenarios of four different ERA-worlds were completed, was to evaluate what does this mean for today in terms of policy implications and issues about the European research and innovation system and modes (and degrees) of Europeanisation? To this end, the VERA consortium has created a policy-lensing approach as an additional step in probing these scenarios to provide details that speak to policy shapers. We use the term lensing because the approach translates scenario "worlds" in terms of perspectives from a policy shaper stand point, but also alters and adds to the scenario texts, it requires further elaboration of the scenario world. This hybrid role of translation and further scenario articulation means the approach sits between the worlds of the FTA analyst and the policy shaper, combining the perspectives and assessment processes from both worlds.

In this paper we present three sets of lenses, that have been developed and tested, dealing with policy goals (competitive innovation environment, strong science base and addressing societal grand challenges), functional layers (Orientation, Programming and Performing) and Europeanisation (Integration, Coordination and Juxtaposition). These lenses may be useful for the application of other FTA outputs to the development of Research and Innovation policies, and thus have broader application than the VERA project.

Keywords: Scenarios of the European Research Area, Research and Innovation Futures, Meta-Analysis, Strategic Policy Intelligence

1 Introduction

1.1 Foresighting research & innovation system governance with a view to policy

Understanding and managing national and international research and innovation systems has been high on the agenda for many years now, and a key focus of FTA analysts (Sarewitz et al. 1999, Kuhlmann 2001, Kuhlmann and Edler 2003; Georghiou et al. 2008; Schoen et al. 2011). Focusing on Europe a consortium of ten research teams have come together to explore potential futures in the European research and innovation system, both in terms of foci of research and innovation, governance of the research and innovation system and modes of Europeanisation and consider their implications for European research and innovation policy.

This consortium, funded by the 7th European Framework Programme in the project "Visions of the European Research Area" (VERA)[1] was set up to provide relevant strategic intelligence for the future governance and priority-setting of the European research and innovation system. VERA has a dual focus: geographically, there is a focus on European level research and innovation activities; politically VERA is interested in the governance of these activities. The central movement we consider is on-going shifts in the European research and innovation system of both the activities themselves, policy definition and implementation around specific priorities and the modes (and degrees) of Europeanisation. The assumption is that the European Union has been and is generating a unique situation worldwide dealing both with research and innovation activities and policies. The creation of a "European Research Area" has been used to qualify both the future world aimed at and the transformation processes towards this new world (Hooghe & Marks 2001; Majone 2009, Edler et al. Behrens 2003; Borrás 2004).

With this in mind, VERA has carried out an in-depth stocktaking of research and innovation system forward looking activities in Europe and internationally and a thorough review of trends and drivers of long-term change of European research and innovation systems and governance. On the basis of these insights VERA has endeavoured to develop four scenarios describing potential evolutions of the European research and innovation system, making explicit the critical issues for the ERA's future capabilities emerging from these scenarios, and then exploring subsequent issues for policy discussion today.

1.2 Scenarios as future intelligence for informing policy

Scenario building is one of the most widely established Foresight methods. Most Foresight scholars refer to scenarios as "consistent images of possible futures" (Ringland 2002, p. 2). It is argued that rigorously imagining different future pathways forces us to stretch our mental models and confront our collective and individual clichés, biases (Godet 2001) and anticipatory assumptions (Miller 2007). Furthermore, scenario building is expected to enable organisations to generate projects and decisions that are more robust under a variety of alternative futures (van

1 http://eravisions.eu

der Heijden 2005, p. 5) but also to better unlock the potential of the present by reaping the potential of the complexity of our surroundings (Miller 2007).

Part of the benefit of scenario development is expected to emerge through the collective process of developing the scenarios - the "strategic conversation" (van der Heijden 2005). Accordingly, in several scenario exercises the development process is deemed as important as the scenarios developed (van Asselt, et al. 2010 p. 29). Benefits that are mentioned most often include deliberation of expectations, forming of shared language and common ground across diverse actor groups, raising awareness about upcoming challenges (da Costa et al 2008) and opening up of perception filters (Schirrmeister and Warnke 2013). While these benefits may well emerge within the scenario development process[2] the generation of robust strategies from the scenarios is less obvious. The way the link between scenarios and strategies is conceptualised widely differs for different types of scenarios (van Notten et al. 2003). Some scenarios already incorporate a certain strategy. Often in these cases one scenario describes an optimum strategy and a desired outcome such as e.g. the "Flight of the Flamingos" scenario in the famous "Mont Fleur" scenarios on the future of South Africa (van Asselt, et al. 2010 p.30). This type of scenario is often called "normative" and does not require a specific strategy development phase. Rather, the scenarios can directly be used to discuss strategic options.

In many cases however scenarios do not directly describe the system at stake but different possible contexts or environments of the system. In some of these cases there is no best or worst case scenario, but all scenarios combine different elements into a consistent image that will be perceived to be positive or negative depending on the actor's perspective. This type of exploratory context scenario has been widely used to underpin strategic decision making ever since it was introduced by Pierre Whack for Shell in the early 1970s (van der Heijden 2005, p. 3). In these cases the scenarios create a conceptual wind tunnel where strategies can be tested under various conditions. In this approach the route from the scenario exercise to the strategy building involves several additional steps (Ringland 2002, p. 185). Most crucially a vision of the organisation's or systems' foremost goals and assessment of the current situation need to be developed. In a second step, assets and barriers for achieving this vision are assessed for each scenario. Depending on the organisation's attitude towards risk, different types of strategies can now be developed. A robust strategy will e.g. cater for several scenarios whereas a high risk/high return strategy may focus on a scenario with a particularly high gain. In any case, the scenario exercise enables the adoption of an adaptive strategy by monitoring the evolution of the critical factors highlighted in the scenario exercise. Finally, depending on the power of the organisation it may be decided to attempt actively influencing the context towards a certain desirable outcome.

1.3 The scenario approach that was applied

To be able to support future oriented strategy building for research and innovation actors in Europe, the VERA project took scenarios as its central methodology. The objective was to develop contrasting scenarios which would aid the consortium in exploring the key issues, drivers and interdependencies of future research and innovation landscapes (Popper 2008, Robinson 2009, Van Vliet et al. 2012). A full detailed description of the scenario development

2 It is often stressed however that in order to achieve lasting impact the mindset of the scenario building needs to be incorporated into the organization (Ringland 2002, van der Heijden, Pillkahn)

process is given in Teufel et al. 2013, but we summarise the process here and in Box 0[3] provide summaries of the scenarios that were developed.

For the VERA scenarios, a key factor approach was chosen from the variety of available scenario development methods, and was applied following the common four step approach:[4]

a) The identification and selection of key factors,
b) The development of alternative assumptions for each factor, referred to as "factor projections",
c) The development of different scenarios as consistent combinations of these assumptions, and
d) The writing of scenario essays on this basis.

This process enabled a systematic and transparent scenario development with distinct scenarios of European RTDI governance and its context. Workshops were also employed as a tool to develop alternative factor projections making use of stakeholders' knowledge, insights and expertise (van Vliet et al. 2012, p. 755). This allowed the expansion of the set of alternative aspects that would feed into the scenario and further elaborate the interdependencies and tensions between them.

The scenarios that were developed using the "Three Horizons" futures technique (Curry and Hodgson 2008) with some elements of multi-level entanglements (Genus and Coles 2008; Robinson 2009; Smith et al. 2010). Such perspectives assume that alternative future developments and configurations of the research landscape and its global, socio-economic context exert external pressure to change on the system of RTDI governance over time. Following this thrust, the selection of key factors is not only attributed to the form and mode of European research and innovation governance, but also to the (global and European) research landscape and practices and related aspects of the global, socio-economic context (Teufel et al (2013) p3). The resulting four scenarios (summarised in Box 0) represented four different evolutions of the present day research and innovation system.

Box 0 : Scenario summaries

Scenario 1: Private Knowledge – Global Markets

In this scenario, today's European Research Area gradually evolves into what one might call a Global Innovation Area, where research is mainly legitimized by its contribution to innovativeness, competitiveness and growth. As a result of limited public funds, growing inequalities between Member States and the jostling for political influence within Europe, private actors, mainly firms, dominate the financing of the research landscape and thus the setting of research priorities. The coordination and integration of worldwide research, technological development and innovation are primarily managed by global, vertical networks and value chains.

Scenario 2: Societal Challenges – Joint Action

In this view of the future, today's European Research Area has developed its research and innovation capacities incrementally as efficient responses to the Grand Societal Challenges. This means that economic growth and job

3 We have labelled it Box 0 to emphasise these scenarios are the FTA intelligence that is the object of the policy lensing approach described in this paper.
4 See Dönitz et al. 2013 (p. 13) for a description of a similar four step approach.

creation have become an even stronger priority, and that issues like climate change or health protection are perceived as Grand Challenges. For the governance of research, technological development and innovation, this means that national governments play a strong role, but regions also evolve into powerful political actors. Compared to the European research and innovation system of 2014, orienting joint action along specific thematic lines in different European sub-regions means differences in economic and innovative capacities across European regions and states, leading to less Europe wide integration, but to European sub-region integration.

Scenario 3: Solutions apart – Local is beautiful

This scenario captures the vision that today's understanding of progress is transformed into a human-centred rationale, where e.g. happiness and quality of life are operationalized into new measures of progress. Research and innovation in Europe are transparent and open to individual or societal needs, in particular regarding new ways of living together, health or data privacy. The main new element in the governance of research, technological development and innovation is the increased participation of citizens. The open landscape for research, technological development and innovation provides a good basis for close ties with society around micro/regional level activities where society can become involved and/or invest in research and innovation activities.

Scenario 4: Times of Crises – Experts at the Wheel

This scenario takes up the idea that today's economic rationales (jobs and growth) have been transformed into an approach where a sustainable development path is viewed as the main rationale of progress. European-level coordination and policies play a strong role in steering research, technological development and innovation towards the overall goal and, at the same time, in worldwide networking and managing international collaboration. Experts play key policy roles becoming heavily involved in policy definition and implementation. Research is funded by a wide range of actors, who define programmes primarily to deliver useful outcomes for sustainable development. Private and public sector research around the globe is increasingly complemented by "citizen science"; as a consequence, the role of the "expert" extends and expands significantly.

The four VERA scenarios in Box 0 differ from the wind tunnelling type of scenarios in two key respects. Firstly, they are not pure "context scenarios". Rather the behaviour of several key actors' such as European and national level RTI policy makers, universities, NGOs, citizens and industry is actually incorporated into the scenarios along with some more factors more external to the RTI system such as the global economic situation. This approach is in line with the insight that in the case of policy oriented scenarios the wind tunnelling is less useful as "policy free" scenarios will hardly provide relevant storylines (van Asselt, et al. 2010 p.41), Secondly, in contrast to many of the textbook cases that were developed for one particular client, the VERA scenarios are meant to support future oriented strategy building for a wide range of actor groups concerned with research and innovation in Europe and beyond. Each of these actors needs to engage in their own sense making process in order to draw conclusions for their strategy building. Following the notion of adaptive Foresight (Eriksson, Weber 2008), the VERA project has set up such a strategic process within eight focus groups each targeting specific stakeholder groups.[5]

1.4 A need for a further step of translating the scenarios from a policy perspective

Even though the four VERA scenarios have proved to be valuable catalysts for strategic conversations in various stakeholder groups such as universities, research funders, industry and civil society they hold particular relevance for policy makers active in research, innovation and

5 C.f. VERA Workpackage 5 see http://eravisions.eu

technology policy. However, the often very rich and complex exploratory scenarios that are incorporating policy as an endogenous element are difficult to translate into policy relevant intelligence. In fact, we have found the literature rather lacking in this regard. Thus there is a need for amplifying these scenarios with respect to a policy perspective.

With this in mind, in this paper we present "policy lensing" as a tailored approach to sense making and linking exploratory scenarios to future oriented strategies for policy shapers. Policy-lensing is an additional step to help transform FTA intelligence, like the four VERA scenarios, into a form that speaks to policy shapers. We use the term lensing because the approach translates scenario "worlds" in terms of perspectives from a policy shaper stand point, but also alters and adds to the scenario texts: it requires further elaboration of the scenario world. This hybrid role of translation and further scenario articulation means the approach sits between the world of the FTA analyst and policy shaper, combining the perspectives and assessment processes from both worlds.

This paper walks the reader through the process. It first describes the policy lenses chosen and why. It then presents one example VERA scenario, and shows the lensing and filtering through. We then reflect on the process and its broader application. To keep this paper to a reasonable size, we have limited ourselves to showing the process for one of the four VERA scenarios only. However, you can find a full draft version of the four policy lensed scenarios at www.policy-lensing.com.

2 Three policy lenses

To be able to explore the future scenarios of the European research and innovation landscape, as analysts we put ourselves in the position of a policy shaper. First, policy shapers[6] dealing with research and innovation today have policy priorities. Next policy is developed and implemented in different functional spaces that need to be considered separately (it is not the same to define a policy and its rationale, implementing it, and having societal actors responding to it). Thirdly there are questions of Europeanisation, which forms are possible, desirable and (un)necessary.

This section will outline the three policy lenses that we have developed to help us probe the four research and innovation scenarios developed within the VERA consortium.

2.1 Lens 1: Three policy priorities in research and innovation

There is a long-standing categorisation of the types of policies, associated with theoretical developments about the role of states and Governments (e.g. Chaminade & Edquest 2010). It recognises three major priorities: research and innovation for Government missions; shaping the innovation space (with protection of inventors, protection of users and coping with market failures); and support to the specific (quasi) public good that is science. OECD development goals speak about the changing balance in time and space between these 3 priorities (Brooks et al. 1971).

The early ages of Government involvement in science and technology have been associated in most developed countries to Defence, where Defence has remained the largest public spender in quite a number of countries, well after the end of the cold war. The enlargement of the sphere of Government missions is a major phenomenon that spans the last century – for example with

6 We use the term "policy shapers", rather than "policy makers", to broaden the notion of the users and appliers of policy intelligence to shape research and innovation policies.

communications, energy, health and environment – even if modes of interventions have changed over time. In many countries, mission-based public funding represents the vast majority of central expenditures, the US being the paramount example of this focus. Mission-orientation was central at the time of the first EU-level interventions building the core of the pre-framework times, and has now been transformed into more open-ended objectives defined as “grand” or “societal” challenges.

Invention and new products have been at the core of the ‘capitalist revolution’. Protecting inventors so that they can bear the fruit of their inventions is written in the US constitution; national systems as we see them now have emerged in the 1840s, and the first international trade treaty was dedicated to industrial patenting. Framing market conditions is a central remit of policies, and has been de facto a central element of the Europeanisation of markets (with standards in particular). However one cannot understand the very old and, for a long time fast growing, intervention of Government in innovation without considering the notion of market failures (more recently enlarged to system failures - requiring direct Government support). Also of importance is the fact that intellectual property is at the core of renewed trade discussion should thus surprise nobody: patents are an intrinsic part of the growth dynamics, as has become their counterpart, user/customer/worker safety that is the other facet of Government shaping of markets.

The post WWII environment following the US Bush report (1945) made of science and fundamental research the key source of major innovations. The need for research policy in support of basic and fundamental research is thus predicated on such utilitarian considerations.. Currently fashionable policy concepts like ‘research excellence’ and ‘frontier science’ reflect this focus on the importance of basic research.

Our central assumption is that the balance between these 3 types of intervention is critical to the characterisation of the “research and innovation landscape”, and is an integral part to consider in our 2030 scenarios. What explains the relative position of one or the other, and understanding their modes of deployment in the governance of the European research and innovation landscape is an intrinsic dimension of the internal coherence of scenarios.

Box 1 Lens 1: Types of research and innovation policy

(1) **Research and innovation framework policies:** shape the adequate institutional infrastructures (IPR, standards, and other regulatory interventions including tax regimes and public procurement practices).

(2) **Mission-oriented and challenge oriented policies**: define substantial problems that need to be addressed through science, technology and innovation. Often combine different tools and funding programmes to mobilise a broad base of research and innovation actors.

(3) **Support for basic and fundamental research:** We can differentiate two main avenues to provide such support: through the public funding of research in universities and their associated organisations, or through dedicate public research organisations (such as academies of science). We will also encounter different balances between ‘core’ and ‘competitive’ allocation of funds across countries.

2.2 Lens 2: Three functional layers of research and innovation policy

. A long OECD tradition (linked to the post WWII construction of ‘science and technical policies’, later extended to ‘research and technology policies, and now to ‘innovation policies’) separates two universes: resource allocation on the one hand (associated with policy definition)

and performance on the other. Barré and colleagues (2013) have recently proposed a further enlargement considering a functional approach to policy, differentiating orientation, programming, and performance as "macro-functions" in research and innovation policy. We propose to adopt this model to describe the research and innovation landscape in Europe as three nested functional layers (see Box 2).

Box 2: Lens 2: Functional layers

(1) Orientation functional layer: Involves the definition of policy objectives and the ways in which the policies envisaged will work towards the achievement of such objectives

(2) Programming functional layer: Involves the translation of the objectives stated by the orientation layer into interventions implementing specific thematic priorities, and the allocation of resources to such interventions and eventually to Research and Innovation performers

(3) Performance functional layer: Responsibility of research performers (PROs, Universities, firms, others): production of knowledge and innovation through the activities of researchers, operation of research infrastructures, management of projects, networks

2.3 Lens 3: Modes of Europeanisation

The third element of our policy lensing focuses on a key aspect of research and innovation system for the European Research Area: the types and modes of Europeanisation. The dominant paradigm in international affairs is that countries/states are the basic unit of analysis and that the dominant mode through which countries relate to one another is 'inter-governmental cooperation'. In some cases specific bodies are created in charge of a dedicated activity and countries delegate budgets and implementation to these bodies. Science and technology have been an important source of such creations, with two complementary models of intergovernmental cooperation: one driving to the creation of a performing entity (like CERN or numerous other large scientific instruments), the other driving to the creation of a funding agency (like ESA).

The creation of the EEC and then the EU has generated another development, by creating a 'federal layer' (e.g. Trechsel 2013), which in turn develops a "research and innovation policy" that is operated on the basis of the global budget delegated to Europe: framework programmes (and their specific sub-programmes) have been the outcome of this process. Recent years have witnessed additional developments:

a) multiple new frameworks have been developed to support and foster inter-country cooperations (ERA-Nets, JTI, Article 185…). Most of these new developments no longer take place at the 'orientation' layer but at the 'programming layer' (between agencies, and sometimes in combination with large performing organisations).
b) new European instruments have been created to share some orientation and programming functions (programming strategies, selection procedures, monitoring of results and effects) while funding remains within the hands of the respective national funders: EUREKA has been a front-runner in this movement.

These changes have been studied in depth in a European project (JOREP) and its results published recently (Lepori et al. 2014). This has driven Barré and colleagues to highlight two

complementary approaches to Europeanisation – integration and coordination - besides the historical situation of 'juxtaposition' (see Box 3).

Box 3: Lens 3 - Modes of Europeanisation

- Integration: **full delegation** of decision making to a single European level entity with considerable autonomy and independence; strong and formalised institutionalisation, single budget
- Coordination: **joint** decision making by concerned (national or regional levels) entities, based on **common** understanding, guidelines and framework of reference; decisions apply to each entity which implement them on a voluntary engagement basis
- **Juxtaposition**: co-existence of entities acting in non-concerted way, in the ignorance of each other and / or in competition with each other

3 An example of lensing with one scenario

This section provides the full texts of a single scenario and its further policy lensing (see figure 1). We first present the full example scenario which has been developed as described in section 1.3. We will then present the application of lens 1 in terms of policy priorities and then present the further lensing of scenario through lens 2 & 3 which were applied at the same time.

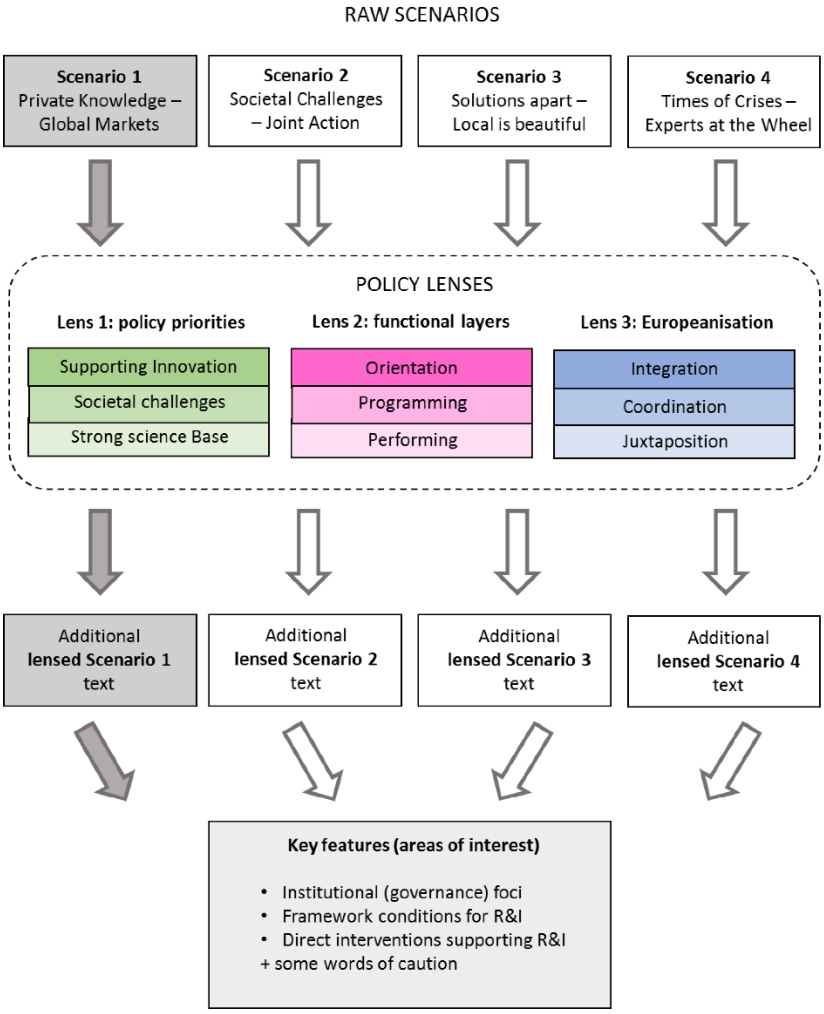

Figure 1. The policy lensing process from original scenarios to identified key features and areas of interest. Along with the lenses, those boxes shaded in grey shall be presented in this article

3.1 Step 0 - A raw "unlensed" scenario

Below we show a full example of one of the four scenarios outlined in box 0, for the purposes of the policy lensing process.

Private Knowledge – Global Markets

As a consequence of a series of financial crises, the variety of approaches to economic recovery have led to locked-in growing inequalities between countries and regions within the EU, less due to continued EU enlargement, than to crises in some of the "old" economies of the EU-15. Due to economic heterogeneity, political jostling has increased, impeding joint action. The financial situation across Member States remains heterogeneous and unpredictable, leading to most European companies focusing on short-term economic survival in a turbulent financial landscape. Technology-intensive sectors find it difficult to maintain medium- to long-term business strategies, leading to more risk-averse spending in RTDI.

Public austerity policies leave national governments relatively little room to manoeuvre in the funding of RTDI. And as overall public spending on RTDI has dropped, there is a shift of

financing to private domains. This means de facto that private actors such as big corporations and lobby organizations have gained significant agenda-setting power to align public RTDI activity with market interests.

The coordination and integration of worldwide RTDI is primarily managed by global, vertical networks and value chains. European industry, where the lion's share of European RTDI funding is located, engages in global RTDI networks to safeguard its competitiveness.

In the EU, the remaining small share of public research is horizontally coordinated by closed circles of EU Member States, such as DACH or ORA (Open Research Area), regions and specialized research clusters, and limited to single win-win domains for competitiveness, such as the exchange of highly qualified researchers. Limited public budgets create an incentive for intergovernmental coordination and joint action to strive for critical mass. Still, due to the increased heterogeneity in a European Union of now 31 Member States, political jostling has also increased, so that the number of states actually collaborating in such initiatives is rather small. Some regulatory frameworks of the former ERA concept still persist, such as the free movement of researchers and open access infrastructures (although enhanced mobility also leads to tensions and conflicts, see below). The European Union bodies, in a trustee-like relationship, monitor compliance with these EU-level regulations, but have little to no power in coordinating research funds or influencing research priorities. While research in some developed countries has significance for society at large, it is not a major issue in European societal and political discourses. The value of research is mainly seen in economic terms. Besides established firms, successful start-up entrepreneurs and representatives of competitive research organizations have gained selective access to policy arenas in the form of rather closed consultation processes.

Research worldwide is justified by the promise of successful commercial exploitation. As the capacity of national governments to fund Research and Innovation programmes is very limited, societal needs that are not covered through commercial dynamics are increasingly addressed by philanthropic organizations, which actively support and coordinate research that is in line with their objectives. Irrespective of the funding sources, research is widely considered to be an entrepreneurial activity. In Europe, purely publicly funded research is rare and limited to genuinely public domains (i. e. security research). The scarcity of public capital means that the legitimization of any basic research conducted comes under strong pressure, with multiple selection criteria based on the promised potential exploitation of the expected knowledge production.

A substantial share of global research activity is carried out as a specialized, globally distributed activity embedded in differentiated value chains. Universities worldwide focus mainly on applied research, with basic research strongly tied to its expected relevance for future exploitation. This approach relies heavily on the involvement of private investors and vertical, international networks and cross-disciplinary research groups. The relative share of private investment in RTDI has increased globally. The largest share of private sector research worldwide takes place in China and other expanding economies, driven by the shift of lead markets such as health care systems and new models of mobility to these countries. A Global Innovation Area emerges due to the world-wide distribution of RTDI activity, where links to specialized global knowledge and lead markets are vital for a firm's or region's competitiveness.

The research landscape in Europe is mainly influenced by knowledge-intensive sectors that are concentrated in the stronger, globally interconnected regional economies. The bulk of RTDI activity is carried out by firms; however, financial constraints and cost reduction strategies have split the organizational research landscape into private research providers, joint ventures between big firms, and public-private consortia. Moreover, the turbulent financial landscape

hampers long-term business strategies and expensive, high-risk research activities. This causes some firms to include fewer research-intensive innovations in their product and service portfolio, others to deepen their involvement in global value chains in order to access research activities outside Europe.

Due to the shift in research activity from the public to the private sector, the main product of European scientists is closed-door research, with private exploitation regimes predominating. Accordingly, IPR regimes play a strong role wherever they can be enforced.

Competition for RTDI jobs is high. With national governments keen to retain RTDI jobs, the pressure on firms to "hire locally" means that any foreign candidate is required to fulfil multiple additional criteria. In addition, the competition for highly qualified researchers and a brain-drain from some Member States to others creates tension with the free migration of the RTDI workforce across the European Union, which comprises 31 Member States in 2030. These issues are on the intergovernmental agenda, but are not resolved and remain an ongoing concern for the Member States.

In most parts of the world, GDP growth and job creation remain the dominant indicators of wealth creation. As cities, states and global regions compete in a globalized economy, additional indicators of progress and wealth such as "sustainability", "equality" or "quality of life" now exist in niches dotted around the more economically developed areas of the world. The moderate growth of the world economy is mainly driven by the continuing expansion of economies like India, Brazil or Mexico. Their economic success is based on the production of knowledge-intensive goods and services. Both democratically elected and autocratic governments strive to demonstrate their ability to stimulate economic growth and job creation, considering economic growth an effective way to prevent societal discontent and unrest. In developed countries such as China, Europe, North America and Japan, the slowing and declining GDP amplifies international competition, reinforced in most parts of the world by a shift in economic power from public to private actors.

3.2 Step 1 – Scenario 1 through the policy priority lens

In scenario 1, economic growth (seen mostly as revolving around private sector investment) is the main force driving policy design and implementation. The world is increasingly globalised and thus competitiveness is the central motive driving policies both at European, national and regional levels in Europe. The focus on economic competitiveness and growth has become even more pressing given that Europe has been slow to get out of the crisis and that the need for budgetary restraint is still a major constraint for most national and regional public authorities. Consequently, the private firm becomes the main locus for research and innovation. Research and Innovation policy focuses on supporting the innovation capabilities of private firms. At the European level this means 'framing' an environment that supports innovation in the firms. The development of the science base become subordinate to this main objective: a strong science base is seen as a way, even a requirement, to enhance the breakthrough capabilities of large firms (that are all global and represent the core of world industrial R&D[7]) and to nurture a rich

7 The 200 largest R&D spending firms represent half of world industrial R&D and the first 2000 over 80% (source: IPTS scoreboard).

and lively ecology of 'new technology based firms'[8]. Similarly the dominant way to address societal issues is through public private partnerships that can harness the capacity of the private sector to address social challenges through the creation of new products and services, and the generation of new business models.

3.2.1 Policy priority 1: Framework conditions for supporting innovation at the firm level

The focus in this scenario is on the creation of a friendly environment for innovation at the firm. A crucial element of this environment is the existence of common European rules: IP, standards, innovation-based procurement, shared approaches to support for "new technology based firms". All these "intangible" dimensions are complemented by a tangible one: the communication infrastructures that link and articulate the European market. All other classical 'market failures' interventions – for a strategic sector or for supporting SME – remain 'national' or 'regional'. The following paragraphs develop these points.

Europe has been able to develop a common innovation ecology based on common shared rules and practices. A key feature of it is a completely **integrated approach to IP and patenting**: a single application will cover the whole of European countries thanks to an integrated process associating all existing offices (multiple options are possible), but also through a specific enforcement structure (in particular with the development of a European Patent court). Common European practices have also developed for (i) **standardisation** with European standards bodies becoming dominant vis-à-vis a minor role for national offices and a unified participation into international standardisation offices); and (ii) **public procurement** with public sector markets open to European-wide competition thanks to more encompassing directives effectively translated into national legislation and practice, and a shared definition of entities considered as 'public'.

A second dimension of the friendly environment for private sector innovation is the existence of an efficient and comprehensive European **communication infrastructure.** This extends to both physical transport and telecommunications. There has been long-standing work to explain the role these infrastructures play in the competitiveness of firms. Private firms have been key in setting and operate up this infrastructure supported by public sector investment and regulation, including substantial R&D expenditures, which have been used to support a strong technological base in communications and a sound regulatory environment. The resulting infrastructure articulates a space that represents 40% of the world market, with the existence of strong firms both in equipment and operation.

Other public interventions will target 'market failures' and the local support of small / mid-sized firms. The latter will remain national or regional adapted to local problems and being therefore very varied in their volume, modalities and direction

3.2.2 Policy priority 2: Societal missions

The possibilities of implementing the lasting discourse on the need to orient research and innovation to the solution of societal problems remain heavily constrained by the limited financial means at the disposal of Governments. Organised actors, other than government organisations have come to play a central role in the launch of research initiatives to address societal

8 We use this term rather than start-up firms (many are not technological) and spin-off firms (many do not come out of universities)

problems. There are three main types of organisations behind the funding and implementation of such initiatives:

1. **'collective experiments'** bringing together interest groups, local associations, and at times, local government developing new approaches to fund and organise R&D initiatives, placing very limited demands on the public funding system;
2. **philanthropic organisations**, some of them very large and of international scope (following the Bill & Melinda Gates Foundation "model");
3. **'public-private partnerships'**, where public authorities co-invest with large firms with the view that the solutions developed will generate new market opportunities.

In one word, reflecting the budgetary situation, Government plays a very limited role in the choice of problems to be addressed and the definition of priorities. Following this logic, at European level, research funds available through the European institutions have remained constrained. The European institutions continue to develop and implement research and innovation policies to address societal problems, but the instruments used seek to stimulate and coordinate the contributions of other actors. This will entail more 'à la carte' participation and a de facto layered Europe.

When looking at the different challenges being discussed today (2014) we see two of them as having been taken up at European level in a significant way:

1. **Energy transition** continues to be a research priority, supported through PPP. Special attention is being paid to energy production (including decentralised production technologies) and transport. Other fields of research like low energy consuming equipment and devices are being driven by different actors and through mechanisms similar to today's Forestry stewardship council. This will also apply to a range of products associated with climate change and the search for lower carbon footprints; mostly supported by concerned citizen groups.
2. **Health issues**, remain important mostly those associated with ageing and lifestyle (obesity, diabetes, etc.). This is a field with scope for PPP articulated through instruments like new JPIs mostly focused on the development of new treatments (drugs, vaccines…). These are societal problems that offer also potential for firms to generate profits: co-investment between the public sector and large firms has become very common practice[9].

Firms are active in these two areas, as they constitute important and growing markets. Other societal missions, offering lesser scope for the generation of commercial profits have remained the remit of collective experiments or philanthropic organisations, and are not the subject of large coordination between governments.

3.2.3 Policy priority 3: Support for a strong science base

The core motivation for investing in the science base is to support competitiveness and economic growth. Excellent science is important for these goals, but is concentrated in a few large leading research organisations (mainly universities) offering an able counterpart to large

9 This may happen under a new form of PPP where large firms co-invest in initial stages of developments and the creation of start-up firms, against a priority to buy them at a later stage. Such developments are clearly linked to a reinforcing of the oligopolisation of the pharmaceutical industry, and the ability to retain large European players

firms. This strong scientific research nodes are very important for both supporting the long-term knowledge needs of large firms and for nurturing a lively ecology of new technology based firms. They thrive at the frontier of science and technology and have access to funds to support such research. They receive substantial private funding, but also some public support. As overall public resources to support scientific research remain stagnated, the backing of such centres of excellence means a concentration of research funding and a reinforcement of funding at the European level for responsive **frontier science and technology**.

Two important outcomes of this scenario are (i) a stronger **concentration** around key science 'clusters' in Europe, and (ii) a greater **dualisation of Universities**, with a vast majority of universities focusing on professional/vocational education (with probably a greater role of life-long learning) and a small group of research-led elite universities. The former are oriented to serve local actors and the local industry, whereas the latter act as global actors in global knowledge markets.

3.3 Step 2 – Europeanisation mode and functional layers

What governance is implied by this priority on competitiveness? We consider the three policy functional layers in turn and within them we focus on what happens at the European level and how.

In a nutshell, this scenario does not involve any major change in the ways priorities are set and political compromises built at the European level. There is however a breaking up of the overarching approach to implementation (the Framework programme-type of intervention no longer exists) and a 'sectorialisation' of research & innovation interventions. The different DGs are in charge of developing and implementing their R&I policies. "Horizontal" activities like the support for basic research and the implementation of IP policy are carried out by powerful autonomous agencies. The limited funding capacity of the public sector is counter-balanced by the rising role of NGO and philanthropic organisations that, even though often very specialised (e.g. on an orphan disease), collectively cover a wide range of domains.

The following paragraphs elaborate this state of affairs for each policy functional layer.

The ***orientation*** function at the European level does not attempt to cover the whole spectrum of research and innovation activities; instead it focuses on institutional aspects linked to competitiveness and the development of a friendly innovation-ecology (IP, standards, rules for procurement). This represents a clear change from today's core debates on policy orientation with its focus on the resources and priorities given to the common R&D support programme (for many year called Framework programme). The **programming** function has also changed significantly, with this common, all-encompassing programme disappearing, and R&I interventions being developed and implemented by the different DGs in a "sectorialised" context. Only some horizontal activities, like the support of basic research are conducted by agencies. These agencies have been reinforced and have gained autonomy. Two important agencies have witnessed substantial transformation:

- An agency in charge of the development and implementation of all IP policies; integrating a single European patenting office, trademark office, and all activities related to the protection of other Intellectual Property Rights. An EU-level enforcement system is in fact being implemented through this single agency.
- A single agency, following on the steps of the European Research Council, will be responsible for the support of basic research at European level.

Within this context, some of the core policies in the current EU innovation policy landscape have undergone important changes. First, the support of SME's innovation capabilities remains high in the agenda but given the budgetary constraints, interventions are channelled either through sectorial policies or through dwindling structural funds. The outcome is a diversity of instruments, many of limited size and targeted to specific sectors or activities. Such fragmentation compounds the difficulties that SMEs face to follow these instruments and access the limited funding available.

Second, the role of "societal challenges"[10] as a major dimension of current European discourse has all but disappeared.. In the current scenario, Governments have limited means to address them and the sectorialisation of European policy (in part triggered by squabbles over dwindling funds) means that coordinated inter-departmental approaches can no longer be implemented. The importance of such broad societal challenges continues and is still recognised, but policy discourse has transferred the responsibility to tackle them to "bottom-up" initiatives coordinating different societal stakeholders. When the market is not enough to coordinate such activities, it is the "new society" that organises itself to address societal problems without relying on bureaucratic State organizations. It is the co-investment of societal actors – both in defining the directions and shaping the ways to address them - that is expected to be sufficient to address the societal challenges. In so doing, three groups of actors play a central role: large firms with capabilities to invest on long-term R&D entering public-private partnerships to address societal problems and creating new markets on the way; 'concerned groups' mostly organised by NGO with clear foci (e.g. a given disease) and looking for solutions to it; and targeted groups of public authorities, including national governments that consider an issue so important (in political terms) that they need to address it.

Although the rhetoric is compelling, orchestrating and coordinating such a diversity of groups within a context that is driven by private actors following growth strategies, means that very few 'challenges' have been addressed by such co-investment initiatives. Instruments such as JPI have survived over the decades but are used sparingly. When they do, the operationalization of such bottom-up, broadly based, international initiatives have mostly relied on joint programmes articulating funding agencies in an ERA Net-like fashion[11] with NGOs, and large private firms. Inter-governmental co-operation has thus become an important element when addressing societal challenges and the EC role, when it exists, is limited to that of 'another member' rather than an overseeing and orchestrating member. Instead, the role of NGOs as become important in pushing issues to be considered "societal challenges" and bringing together different actors in a flexible and constantly changing architecture.

NGOs role has also become more important in fields like sustainable fishing or forestry through their contribution to stewardship councils. In this scenario, they have also replaced the role of Governments in standard-setting, and are playing a central role in the implementation of strong

10 It should be noted that "Societal challenges" must be distinguished from the pursuit of government missions, as understood by the OECD terminology. The terminology of societal challenge warrants the recognition of an important problem that cannot be handled with the usual departmental processes and means. Specific ways of defining the problem, the new knowledge required to address it and the ways to conduct the efforts have to be identified and put in action and involve a variety of actors (different ministries and agencies, different scientific disciplines, many social groups and stakeholders). Thus, a policy to address a "societal challenge" goes beyond 'business as usual'

11 See Lepori et al., 2014 for further developments

certification policies[12], at times embedded in enlarged ISO processes (as is being the case today for the 26000 series on social responsibility).

Concerning the ***performance*** function, the role of the public sector has also seen a marked reduction when compared to today's (2014). **Universities** are the key feature of the public sector in this scenario. These have undergone increasing differentiation, with 'excellent science and technology' being concentrated in a small number of universities. Around these leading universities, a rich ecology of new technology/science based firms and of research centres of large firms has developed. In contrast to these few, leading universities and their surrounding "ecosystem", the majority of universities address the regional needs for skilled and knowledgeable workforce. The vast majority of universities are therefore teaching-led and focus on professional/vocational education. They do undertake research activities, but these will mostly be problem-driven and oriented towards helping local economic actors. This type of research will seldom be frontier research, but rather will seek to adapt and further develop knowledge to provide solutions to well-defined technical problems.

4 Deriving policy issues from the lensed scenarios

In the previous section we have presented the raw scenario, followed by the elaboration and further lensing of the raw scenario in terms of policy interests. The lensing of this example scenario, and its three sisters (see Box 0) allowed us, the authors of this paper, to derive a set of policy and institutional features.[13] Based on these features we could identify current policy issues. Our selection focuses on policy issues at the European level related with key features that are present in more than one scenario; in other words issues that emerge as key in very different social and political contexts. Our analysis (given based on analysis and lensing of all four scenarios) distinguishes three main types of policy issues: (1) institutional, (2) framework conditions, and (3) direct interventions.

In the remainder of this section, we define and address these in turn and we conclude with a consideration of several assumptions that underlie most current policy practice and which are questioned under several of our scenarios and thus emerge as topics for policy discussion.

4.1 Institutional

Institutions, understood here as formal organizations operating according to sets of rules and routine practices, are central to all the scenarios. What is relevant, however, is that the same institutions appear in several scenarios, albeit playing different roles. Different political contexts place different responsibilities on the same institutions.

4.1.1 The European Union and its institutions

Scenario 1 presents a situation in which public sector institutions are generally weak and fragmented. In a context of budgetary restraint, national authorities have struggled to retain a degree of influence over the political process and of control over economic resources. The EU and its institutions have not been able to grow and expand their size and remit, and their role has remained limited to setting regulatory structures and other framework conditions in areas

12 Contrary to the new developments of soft law and codes of conduct (see Delemarle and Laredo, 2014, on nanotechnology)
13 In the actual process we (the analysts in the VERA consortium, and authors of this paper) derived 55 policy and institutional features.

where national authorities have decided that a degree of international coordination is absolutely necessary to support the activities of the private sector. The EU becomes a further agent, negotiating regulations and other interventions with nation-states and even regional authorities in a context of "variable geometry": the alliances and arrangements across Member States and the European Union will vary from topic to topic.

Scenarios 2 and 4 present a very different situation. In them, the EU and its institutions have become a key player, growing in size and legitimacy, and taking over responsibilities that currently are the remit of national and regional authorities. Yet, as the scenarios illustrate, the political configuration of the EU institutions will depend on the political context. In scenario 2, European societies come together to deal with policy problems whose solution exceeds the capacity of any single State. This transfer of authority to supranational organisations comes accompanied by the development of instruments of democratic oversight at European level: a strong European Parliament provides the source of democratic legitimacy, in an environment where policy concerns are diverse and there are differences across countries and regions as to the main policy challenges that need to be addressed. The situation illustrated in scenario 4 is very different: again the EU and its institutions have come to play a key role but there is a focus on a single set of problems leading to a less diversified political environment, where a "community" of experts in environmental and climate issues play a key role in the governance, not only of the science and innovation system, but of the whole policy agenda.

Finally, scenario 3 is dominated by local and regional interests, and the role of the EU institutions is limited to that of a facilitator, supporting policy learning across communities.

From a current perspective, the scenarios highlight the wide diversity of possible futures as concerning the role of the EU institutions and their governance. Today, the EU institutions may be perceived as part of the political structure: large institutions, with established bureaucracies and long history behind that has brought them where they are. The scenarios inform us both about the plausibility of substantial changes in these institutions, and of very diverse development paths. The evolution of the European Research Area, and of the role of the EU in an evolving European science and technology system can take differing paths, and such paths are associated with the development of different European governance structures.

4.1.2 Agencies

Agencies are independent public sector organisations that contract for a service with a government organisation. They are ad-hoc structures to implement specific policies and are designed specifically for the purpose for which they have been created. Agencies can be set up by government departments at all levels, including supranational organisations. They can therefore be part of the European Union institutions analysed above, but they have a distinctive role to play that was stressed by several of the scenarios.

European agencies are already present in today's ERA strategies; the management of research programmes is being transferred to specialised agencies like the European Research Council Executive Agency and the Research Executive Agency. So far, their role has been instrumental, addressing perceived shortcomings in the management of large research programmes and initiatives. Although in principle one could foresee a broader and more diverse set of functions for European research and innovation agencies, our scenarios describe a more nuanced and differentiated view of the role of agencies. In a context of budgetary restraint and a focus on the innovative capacity of firms, agencies remain an important instrument to deal with specialised activities playing a supportive role: European research funding for fundamental research is disbursed, as it is today, through the European Research Council. The only scenario that describes a role for European agencies does it within a rather constrained remit.

Instead, Scenario 4 places attention on national and regional agencies. This scenario places the EU at the core of a European-wide effort to deal with the consequences of climate change; yet many of the relevant policies have to be implemented at the local and regional levels accounting for the specific local context of application. The flexibility that can be afforded by national and regional agencies fit an environment where the orientation function is performed at the European level, but national and sub-national actors play key roles in the programming and performing functions. This means a proliferation of smaller agencies with limited geographical scope and the EU playing a coordination role, supporting collaborative arrangements enabling systematic but distributed joined-action.

In summary, agencies can play a role within narrowly defined policy areas, or narrowly defined geographical zones. The first alternative leads us to a situation that is not very different from today's, while the second implies a proliferation of organisations and a focus on coordination activities for EU policy, further developing current instruments like ERA-Nets, Joint Programming Initiatives, and Article 185 initiatives.

4.1.3 Civil Society Organisations

All but one of our scenarios contemplates the growth in the research arena of Civil Society Organisations (foundations, NGOs, learned societies, university associations, etc.). Civil Society organisations are gaining influence within the policy processes and becoming an avenue of democratic representation. They are proposing research directions and starting to contribute to the programming and even performance of research. Our scenarios reflect this trend but also caution us that the functions they perform are not predetermined and can evolve into different directions, depending on the political context in which they operate. In a world led by private commercial interests and characterised by public sector penury (Scenario 1), private philanthropic organisations come to cover some of the gaps left by the reduction in public sector interventions; they use their financial capacity to fund programmes and are playing a crucial programming function. In Scenario 2, civil society organisations form part of a broader collection of public and private bodies that operate at various levels and who share in the performance of the wide array of publicly-funded research activities. In Scenario 4, groups concerned with environmental and related matters cover both programming and performing functions complementing the substantial effort driven by the public sector.

Although the role of Civil Society Organisations can therefore vary, the scenarios suggest that they will become a central set of actors to add to government institutions and private sector firms to conform the triad around which the definition, implementation and performance of Science, Technology and Innovation policies will revolve. This is a more complex world, a preview of which we can start to see today in sectors like biomedical research. Coordination to perform the orientation and programming functions has to extend beyond governmental organisation and the conditions under which organisations access funding may also have to adapt to the emergence of new performers carrying out their research within Civil Society Organisations. In other words they need to be engaged in more direct and operational ways than the common exhortations to the need for a "dialogue with society".

4.1.4 Conclusions relating to institutional issues

We have seen how the role of the European Union and its institutions differs across scenarios; these differences will extend to the role played by institutions at national and regional level. The evolution of the balance among the different policy levels is subject to big uncertainties, and we cannot assume that the progression towards a certain model (say, an increased role for the European institutions) represents the natural evolution from the present situation. As we have seen in our scenario analysis, the regional level is, together with the local, the central locus of

STI policy in scenario 3, and it is also important for the experimentation and eventual deployment of innovations in scenario 4. European institutions are dominant in scenario 2 and national government have retained a degree of influence and relevance against the general retrenchment of the State in scenario 1. There is therefore a choice among different institutional architectures and this choice is not neutral in relation to political objectives. For instance, a strong role for European institutions fits with a scenario in which national authorities have agreed to pursue a variety of societal goals requiring international coordination, but cannot be sustained by a scenario characterised by budgetary restriction in the public sector and a focus on private firms as the engine of competitiveness and economic growth.

4.2 Policy priorities: the key role of R&I framework conditions

An important (and somewhat unexpected) outcome of the process is the importance given by scenarios to framework conditions.

It is noticeable that the scenarios have often pointed to the framework conditions of research and innovation as a key objective of STI policy rather than specifying research fields or objectives. Equally important, although framework conditions play a very important role in the scenarios, they do so in very different ways. These instruments are mobilised in support of knowledge generation and application, but the specific ways in which they do so differ depending on the dominant political outlook of every scenario.

Framework conditions as highlighted in scenarios cover intellectual property rights, standards, and regulatory activity (focused on public procurement and on communications). IPR is prominent in scenario 1 as a condition for greater competitiveness of firms, and this scenario foresees the achievement of a full system covering ‘one stop shop’ for granting and a European-level enforcement system (with a dedicated European court). Scenarios 2 and 4 are characterised by large public investments supporting new R&D directions to solve societal problems; here IP policies seek to ensure that the results of such research are publicly available. There are similar differences for standards where they serve the opening of markets for firms in scenario 1, while they are a critical instrument in scenario 4 to reduce the environmental impact of goods and services. There is yet another objective pursued in scenario 3 where European standards are there to make sure that local conditions and requirements are adhered to in products manufactured “outside” (as in Scenario 3). Similar differences in focus apply for regulations surrounding procurement policies.

To sum up, the scenarios have defined a set of policies setting up the framework conditions that are crucial for the future development of European societies (standards, IP, public procurement). These “framework conditions”, however, will be very different depending on the political context within which they operate, and which in turn they help shape. Although it is often seen as a pure technical matter, the scenarios have alerted us to the profoundly political nature of regulatory debates.

4.3 Direct interventions

Although the scenarios focused their policy attention on measures that were setting the framework conditions for R&D and for society at large, there was one sector that called for both regulatory interventions and direct interventions, and that appeared in more than two scenarios: the need to develop a comprehensive and efficient communications infrastructure. The wording covers both the traditional worlds of transport and telecommunications, but also the new word of internet-based interactions. Yet again, the relative importance of each, the balance between indirect and direct interventions, and the overall efforts required vary across scenarios. In scenario 1 the transfer of physical goods is anticipated to be a central concern, and without

environmental issues playing a strong role in policy definition, efficient land, sea and air means of transport constitute a central element of this communication infrastructure. The perception of social challenges is likely to affect the notion of what can pass for an “efficient” mode of communication focusing more on telecommunications, internet ‘infrastructures’ and steering physical communications in directions that are perceived to be congruent with the need to address a variety of societal challenges. In scenario 3, we can expect an even more nuanced view of what constitutes a strong communication infrastructure with a clear focus on internet-based interactions, and the conditions insuring the ability to develop a set of platforms for the exchange of experiences and practices among strong localities.

The remaining direct interventions we noted in our scenarios were unique to each kind of scenario, sometimes even opposite. For instance, scenario 3 relied heavily on the exploitation of the existing scientific and technological base to support localities focused on the achievement of optimal welfare conditions for their citizens; in this context there were no additional direct interventions required in support of specific scientific and technological areas. In contrast, the pursuit of economic competitiveness focused the limited budgets available for public research on the conduct of frontier research and technology. Any investment that could in any way duplicate efforts or support research that may not result in substantial technological advances would be considered wasteful. Besides the limited availability of public funds will push many investments to be carried in partnership with the private sector. The spread of Public-Private Partnerships in research and technological development will require a redefinition of the competition rules; as private investors will seek assurances that their R&D investments will be rewarded through guaranteed access to sufficient markets for the resulting products and services.

The way research is targeted under scenarios 2 and 4 is again different. Societal problems need the organization of research programmes that are system-oriented; that is, instead of focusing on the generation of new knowledge and expect that somehow this knowledge may be applied to address practical issues, the programmes see the application of new knowledge within a complex social system as one of the main challenges of research. This requires special attention to be paid to experimentation, real size demonstrators and “bottom-up” stakeholder participation. There are also differences between scenarios 2 and 4; while research programmes in scenario 4 will target a narrower set of fields and be directly oriented to the search for specific solutions, whereas in scenario 2 there is a wider set of challenges which may be amenable to the development of more progressive, longer-term solutions.

4.4 Words of caution

The policy lessons we have derived from our scenarios may disappoint the reader looking for a clear set of research objectives and priorities to be derived from a future-scanning exercise. Our scenarios have not produced such “solutions”. Instead of finding a convergence in the way problems were defined, and developing a consensual understanding of the long-term needs of society, our scenarios have highlighted profound differences in the political and social priorities that underpin such scenarios. Such differences result in varying understandings of the role of science and technology in society, and of the institutions involved in generating and applying new knowledge. This result has however specific implications for the current policy discussion on the future of the European Research Area. Some have already been discussed in this document but the diversity and even divergence in the way potential future societies might regard the role of science and technology warns us about the inadequacy of some implicit or explicit assumptions underpinning current Science and Technology and Innovation Policy (STIP). These assumptions need to be revisited recognising that STIP is profoundly political, and not a consensual ground in which societies converge led by the recognition of the importance of research in the new “knowledge society”.

Some of the assumptions that are called into question are the following:

- The assumption of: *the promotion of excellence should be the natural overriding objective of research policy.* In fact, except for Scenario 1, the highly selective ethos of this approach was not present in any of the other scenarios. The concern with systemic effects and the application of research to address societal problems were the overriding concern in two of the scenarios.
- Universities should aspire to excellence by improving their research capacity and outputs. The role of universities and the balance between universities and RPOs varied across scenarios. This is a reflection of the different functions that universities play in our societies that are likely to continue to play in the future. Scenario 3 for instance focused on the local role of universities and their teaching function.
- An integrated European R&D system is a precondition for more efficient and effective research systems. In many scenarios, however, integration is replaced by different forms of harmonization. Often the emphasis is placed on the understanding and fit with local conditions and in the development of capacities that can deal with the local and regional qualities of more general social challenges.
- The crucial role of science in buttressing the knowledge society is widely acknowledged. Yet societal attitudes towards science are far from heterogeneous, and the achievement of scientific goals is often considered to be secondary to welfare and other social objectives. This illustrated, for instance, in the reduced role that science and technology investments play in Scenario 3.
- Only strong top-down steering and priority setting will enable us to address global challenges. The scenarios show that may encounter some limitations if it is not complemented by bottom up elements. Orientation may need to span all levels.

5 Discussion and Conclusions

The policy lensing approach has helped us go further with scenarios that were initially developed through desk research, expert engagement and a clear FTA scenario methodology. By looking at these worlds from the view of (a) policy goals, (b) policy action spaces (in terms of functional layers) and (c) modes of Europeanisation, we have further developed and analysed the research and innovation worlds described in the four scenarios (here demonstrated for scenario 1).

This further development enables a next step, the extraction of “Issues for policy discussion today”, when backcasting from these future worlds to today’s research and innovation choices. We have made this step in the VERA consortium, and the full text on “issues for policy discussion” is provided in section 4 of this paper.[14]

14 Though this paper focuses on policy lensing as an approach, we think it important to show what sort of analysis can be made, once scenarios have been lensed. This analysis is given in section 4, and covers all four scenarios. In Box 0, we have provided summaries of the 4 scenarios, but for further details of the policy lensing of the four scenarios, you can find a working document at www.policy-lensing.com or you can go directly to the scenario report (see Teufel et al. 2013)

The policy-lensing approach as we have described it, is not focused on building consistent scenario-worlds per se, but focuses on interpreting and fleshing out these worlds to inform policy decisions today. This means the analyst undertaking policy lensing, retains the tools and skill sets of an FTA analyst whilst placing him or herself in a position of a policy shaper, applying various lenses.

Between the authors of this paper, we have discussed whether the policy priorities and functional layers should have been included in the original scenarios. We concluded, and suggest this to our readers, that the policy lensing expands on the raw scenarios in a very structured policy-oriented manner, drawing on theory to help us derive policy interpretations and conclusions; yet if we had constructed the scenarios guided by such policy frames these may have been more constrained and would not have explored plausible future contexts and developments in the way they now do. We propose that there are two specific contributions of policy lensing as an independent activity after the development of policy endogenous scenarios:

1. **Policy practice oriented refinement** i.e. fleshing out the scenarios with respect to relevant operational policy categories (lens 2). Interpreting the scenarios for the three layers provides a real added value as it bridges from the general policy factors to the operational lens of the policy context. This is something that cannot be done in the collective process of scenario building as it is not accessible to the non-policy participants. In short, it can be a further step in tailoring scenario output into usable intelligence for policy action.
2. **Normative Assessment** i.e. assessing the scenarios vis-a-vis acknowledged policy goals of today. This is visible in lens 1. We feel that this approach yields very valuable insights like, for example, in the raw scenario where “challenge orientation” is no longer high on the policy agenda, through the lensing we could see that there is a potential for progress towards it.

Both aspects are well in line with the notion of adaptive Foresight which suggests a special sense making phase for each actor group and in particular policy.

Finally, we argue that this positioning of the FTA analyst in the hot-seat of a policy shaper requires the development of “robust lenses”. Our interest in this project was on the European research and innovation landscape and aspects of Europeanisation (cf. European Research Area). But of course, other lenses might be developed for exploring scenarios from a policy shaper perspective other than that relating to research and innovation (for example in national or international sustainability policies, energy, transport etc.).

What is *key*, is that the lenses are constructed in a systematic and transparent way. In this short paper, we hope to have provided an insight into this policy lensing approach and philosophy, and we offer it as a potential next step to further enable the uptake of FTA intelligence into policy oriented intelligence.

References

Barré, R., Henriques, L., Pontikakis, D., & Weber, K. M. (2013). Measuring the integration and coordination dynamics of the European Research Area. Science and Public Policy, 40(2), 187-205.

Borras, S. (2004). System of innovation theory and the European Union. In: Science and Public Policy, vol. 31, no. 6, pp. 425-433.

Brooks, H. et al. (1971). Science, Growth, and Society: A new perspective. Paris: OECD.

Chaminade, C. & Edquist, C. (2010). Rationales for public policy intervention in the innovation process: A systems of innovation approach. In: Smits, R.; Kuhlmann, S.; Shapira, P. (eds.): The Theory and Practice of Innovation Policy. An International Research Handbook, Cheltenham, UK (Edward Elgar), 95-114.

Curry, A. and Hodgson, A. (2008): Seeing in Multiple Horizons: Connecting Futures to Strategy. In: Jour-nal of Futures Studies, 13 (1), 1 - 20.

Delemarle, A., & Larédo, P. (2014). Chapter 8. Governing radical change through the emergence of a governance arrangement. The Governance of Socio-Technical Systems: Explaining Change, 159.

Dönitz, E., Shala, E., Leimbach, T., Bierwisch, A., Grigoleit, S. andKlerx, J. (2013): D4.4 Catalogue of threat Scenarios. Deliverable submitted in September, 2013 (M21) in fulfilment of the requirements of the FP7 project "ETTIS – European security trends and threats in society". Available from: http://ettis-project.eu/wp-content/uploads/2012/03/D4_4.pdf [24/10/2013]

Da Costa, O., Warnke, P., Cagnin, C., & Scapolo, F. (2008). The impact of foresight on policy-making: insights from the FORLEARN mutual learning process. Technology Analysis & Strategic Management, 20(3), 369-387.

Edler, J.; Kuhlmann, S.; Behrens, M. (eds.) (2003). Changing Governance of Research and Technology Policy – the European Research Area. Cheltenham: E. Elgar,

Eriksson, E.A.; Weber, K.M. (2008): Adaptive Foresight: Navigating the complex land-scape of policy strategies. In: Technological Forecasting and Social Change, 75 (4), pp. 462-482.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. Research policy, 31(8), 1257-1274.

Genus, A. and Coles, A.-M. (2008): Rethinking the multi-level perspective of technological transitions. In: Research Policy, 37, 1436 - 1445.

Georghiou, L.; J.C. Harper; M. Keenan; I. Miles; R. Popper (eds.) (2008). The Handbook of Technology Foresight: Concepts and Practice, Edward Elgar Publishing Ltd., Cheltenham, UK; Northampton, MA, USA, 2008.

Godet, M. (2001): Creating Futures. Scenario Planning as Strategic Management Tool, London: Economica.

Hooghe, L., & Marks, G. (2001). Multi-level governance and European integration. Rowman & Littlefield.

Kuhlmann, S. (2001). Future governance of innovation policy in Europe—three scenarios. Research policy, 30(6), 953-976.

Kuhlmann, S., & Edler, J. (2003). Scenarios of technology and innovation policies in Europe: investigating future governance. Technological Forecasting and Social Change, 70(7), 619-637.

Lepori, Benedetto, Peter Van den Besselaar, Michael Dinges, Bianca Potì, Emanuela Reale, Stig Slipersæter, Jean Thèves, and Barend Van der Meulen. "Comparing the evolution of national research policies: what patterns of change?." Science and Public Policy 34, no. 6 (2007): 372-388.

Lepori, B., Reale, E., & Larédo, P. (2014). Logics of integration and actors' strategies in European joint programs. Research Policy, 43(2), 391-402.

Majone, G. (2009). Dilemmas of European integration: the ambiguities and pitfalls of integration by stealth. OUP Catalogue.

Miller, R. (2007): Futures literacy: A hybrid strategic scenario method. In: Futures, 39 (4), pp. 341-362.

Popper, R. (2008): Foresight Methodology. In: Georghiou, L./Harper, J.C./Keenan, M./Miles, I./Popper, R. (Eds.): The Handbook of Technology Foresight: Concepts and Practice. PRIME Series on Research and Innovation Policy. Edward Elgar, Cheltenham, UK/Northampton, MA,USA, 44-88.

Ringland, G. (2002): Scenarios in public policy, Chichester: John Wiley & Sons.

Rip, A. (1994). The republic of science in the 1990s. Higher Education, 28(1), 3-23.

Robinson, D. K. R. (2009). Co-evolutionary scenarios: An application to prospecting futures of the responsible development of nanotechnology. Technological Forecasting and Social Change, 76(9), 1222-1239.

Sarewitz, D., & Pielke Jr, R. (1999). Prediction in science and policy. Technology in Society, 21(2), 121-133.

Schirrmeister, E., & Warnke, P. (2013). Envisioning structural transformation—lessons from a foresight project on the future of innovation. Technological Forecasting and Social Change, 80(3), 453-466.

Schoen, A.; Könnölä, T.; Warnke, P.; Barré, R.; Kuhlmann, S. (2011). Tailoring Foresight to field specificities. Futures, 2011, 3, 232-242.

Smith, A., Voß, J.-P. and Grin, J. (2010): Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. In: Research Policy, 39, 435 - 448.

Trechsel, A. H. (ed.) (2013). Towards a Federal Europe. Journal of European Public Policy Special Issues as Books. Routledge

Teufel B., Erdmann L., Schirrmeister E., Daimer S., Laredo P., Schoen A., Robinson D.K.R. and Loikkanen T. (2013) D3.1 ERA Scenario Report (Final Version). VERA (Forward Visions on the European Research Area) Project no : 290705. Submission date 11/22/2013 (http://eravisions.eu/)

van Asselt, M.B.A.; van't Klooster, S.A.; van Notten, P.W.F.; Smits, L.A. (2010): Foresight in action : Developing policy-oriented scenarios: Earthscan Publ. Ltd., London u.a.

van der Heijden, K. (2005): Scenarios. The art of strategic conversation, Second, Chichester: John Wiley & Sons.

van Notten, P.W.F.; Rotmans, J.; van Asselt, M.B.A.; Rothman, D.S. (2003): An updat-ed scenario typology. In: Futures, 35 (5), pp. 423-443.

Van Vliet, M., Kok, K., Veldkamp, A. and Sarkki, S. (2012): Structure in creativity: An exploratory study to analyse the effects of structuring tools on scenario workshop results. In: Futures, Vol. 44, pp. 746-760.