SOCIETAL CHALLENGES: SHAPERS OF PROFOUNDLY DIFFERENT STI FUTURES

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Abstract

There is few doubt that Societal Challenges (SC) are increasingly important determinants of policy in general and of Science, Technology and Innovation Policy in particular. Addressing them requires commitments and investments of societies not only short-term, but rather mid- to long-term. As such SC become important drivers of Forward-looking activities.

In the perspective of Europe and the European Research Area, SC are quite central, constituting one important pillar of Horizon2020. Whereas it seems that there is currently a common understanding in place about the scope and characteristics of SC, we have attempted to show in this paper, that the understanding of SC may vary. Looking at the current US debate for example, we see that there are differences to the European debate.

In the context of the VERA project we have scanned Societal Challenges in existing EU documents and discussion papers that were published and discussed in related foresight and horizon scanning projects. Allowing for such a broader approach with the aim to identify what might be important challenges for a future European Research Area, we can characterize the resulting set of 16 SC clusters in the following way: It has a more global perspective, e.g. in the way it considers migration, impoverished regions, multipolarity and material resources, and it includes more fundamental societal realms or principles such as new values and lifestyles, the role of the state, the stability of public finance, the current economic model, education and EU competitiveness.

In fact, not linking the prioritization of SC to economic growth as the "European approach" does today (JIIP 2012), broadens the understanding of SC considerably (cf also Weber/ Daimer 2014). In light of foresight work, these kinds of more profound societal changes and challenges seem to be of high relevance. As we have shown in the analysis, there is a strong dependency between these central Societal Challenges and other SC, which in turn appear to be subordinate. So, depending on which SC societies might perceive more central to others, societal and political efforts might vary considerably.

Using the scenarios developed in the VERA project, where we interested in the future of Research and Innovation and its governance in Europe by the year 2030, we can illustrate how the different emphasis on central societal principles and challenges affects the perception of other (subordinate) SC. Furthermore, this is not neutral to policy and governance. Quite different models of setting societal (and hence research) priorities and of organising the solutions, e.g. linking science to other sources of knowledge are fleshed out in the VERA scenarios. By way of this, Societal Challenges become important shapers of profoundly different STI (governance) futures.

1   Introduction

In today's political discussions, the notion of Grand Challenges also called Societal Challenges (SC) is very prominent. Today's formulation of e.g. national innovation strategies, EU research and innovation policies etc. show that there is broad consensus that these challenges do have a growing impact on policy making in general and on Science, Technology and Innovation Policy (STIP) in particular.

SC require problem-solving knowledge, which is often interdisciplinary and / or path-breaking scientific knowledge and in many cases they require larger investments in that type of research. So, the future of STI will be strongly influenced by the need to address certain societal challenges, because they will absorb large parts of financial and human resources in STI.

With SC being identified as important shapers of future STI and STI Policy, they constitute integral parts of any forward looking activity in this field – or at least should do so. In the context of our analysis, the foresight project **VERA *Forward Visions on the European Research Area,*** in which different futures of Science, Technology and Innovation (STI) in Europe, and in particular the policy and governance of STI in Europe in 2030 are the in the focus (Teufel et al. 2013, VERA project 2014), SC were thus one important source of factors for scenario-building.

The current political perception and handling of Societal Challenges at European level suggests that "there is something like a common understanding of what the most important grand challenges are" in Europe (JIIP 2012, p. 19). Instead of taking this common understanding as a given trend for scenario building, VERA carried out a scanning and stocktaking of Societal Challenges with a high potential impact on the future European Research Area. We found a large number of SC and developed a cluster of 16 SC, but we did not find an overall consensus about these issues, but rather a variation in the way they have been framed. In each country, in each cultural or societal context SC might be – at least slightly – different.

In this paper, we discuss the set of SC for the ERA as identified by the VERA project. Comparing them to the "European approach" to Societal Challenges (JIIP 2012), we find the VERA analysis to include more fundamental societal realms or principles such as new values and lifestyles or the current economic model. We show in this paper that this broader set of SC including the fact that some of them are in fact challenging fundamental societal values shows quite obviously how strongly some of these SC are interdependent. This in turn, we argue, implies for forward looking studies that depending on different political and societal contexts which scenarios display, the prioritization and emphasis which is given to SCs might be considerably different from scenario to scenario. We show this using the four VERA scenarios as an example.

2   The Societal Challenges Debate

The terms Societal Challenges and Grand Challenges seem sometimes to be used interchangeably. In fact, to a certain extent, they are being used in different contexts. While Grand Challenges has been used much in the US debate, Societal Challenges as a term has a tradition in the OECD. In EU policy documents, both terms appear.

The Grand Challenges approach is originally an idea by US mathematician David Hilbert. His list of important unsolved problems more than 100 years ago has encouraged innovation in mathematics research. Since Hilbert's contribution the concept has, in the US, disseminated to many other disciplines and policy areas. Recently, it gained new strength through the Bill & Melinda Gates Foundation which, in 2003, identified 14 Grand Challenges in Global Health (cf. Giesecke et al. 2012).

In Europe, the concept of "Grand Challenges" was suggested by the ERA Expert Group (EC, 2008) as a rationale upon which to build the European Research Area. A challenge-based approach was proposed on the grounds that the ultimate justification for committing public resources to improving research systems lie in increasing the contribution of public and private research to European social, economic and environmental goals.

The Lund Declaration of 2009 reiterated the importance of such approach, by stating that *"Challenges must turn into sustainable solutions in areas such as global warming, tightening supplies of energy, water and food, ageing societies, public health, pandemics and security."* and highlighting how excellent science and research together with stakeholder involvement, were critical elements of a challenge-based approach.

The aim of the Europe 2020 strategy and its flagship initiative "Innovation Union", is bringing together knowledge and resources interdisciplinary and throughout the spectrum of RTDI activities to support the development of a knowledge-based economy.

Horizon 2020 (H2020), the financial instrument implementing the Innovation Union, embeds such shift in STI policy making. As opposed to previous FPs, in which calls were thematic in nature, the focus was on R&D rather than innovation, and on scientific output rather than broader outcomes, H2020 takes research and innovation from a systemic point of view, tackling the whole spectrum of RTDI and embracing a challenge-based approach. Indeed, in H2020, *Societal Challenges* is, together with Excellent Science an Industrial leadership, one of the three priorities. Furthermore, H2020 recognises the importance of a broad stakeholder participation in STI and STI agenda setting, with article 12 of its regulation (EU-REG 1291/2013) calling for dialogue structures, consultation and transparent and interactive processes within the programme.

Societal Challenges addressed in H2020 are:[1]
- Health, demographic change and wellbeing;
- Food security, sustainable agriculture and forestry, marine and maritime and inland water research, and the Bioeconomy;
- Secure, clean and efficient energy;
- Smart, green and integrated transport;
- Climate action, environment, resource efficiency and raw materials;
- Europe in a changing world - inclusive, innovative and reflective societies;
- Secure societies - protecting freedom and security of Europe and its citizens.

Compared to the Lund declaration, this scope has widened a bit, mentioning know transport and inclusiveness. Apart from the scope of the Challenge debate, it is important to note that the actual definition of what constitutes a challenge is different. While in the US debate, challenges have been defined from a scientific point of view and often internal to single disciplines, the "European approach" can be characterized as follows (JIIP 2012, p. 17f):

- The longer term sustainability of a society or country is at stake
- Mission oriented, looking at solving societal problems and systemic solutions
- Multi-level, multi-stakeholder participation
- Focused on alignment and coordination of strategies
- Linking economic growth to societal benefits
- Combining research, technology & innovation in a multi-disciplinary way

Against this background, the understanding of SC applied in the VERA scanning and stocktaking is broader, more global, and not considering the link to economic growth as a fix characteristic (see below). However, rather than advocating a more precise definition of grand challenges, this paper aims at shedding light on one aspect of the concept, its role as "future shaper".

3   How Societal Challenges shape different STI futures

Scanning and Stocktaking of FLA with a focus on STI addressing the Societal challenges

The stocktaking of societal challenges in VERA had two intentions: First, to better understand the implications of societal challenges on forward-looking activities (FLAs) and in the end on foresight-informed policy-making; and second, to scan systematically the set of societal challenges in order to identify key drivers for scenario-development for the European Research Area (ERA).

The identification of Societal Challenges (SC) was made on the basis of existing EU documents and of discussion papers that were published and discussed in related foresight and horizon scanning projects. We identified more than 760 SC in total from a stock of 71 sources (Giesecke et al. 2012).[2]

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[1] See http://ec.europa.eu/programmes/horizon2020/en/h2020-section/societal-challenges

For the scanning of sources we took into consideration previous EU foresight and horizon scanning projects like EFMN, EFP, iKnow, ForSociety, ForLearn, ForWiki , SESTI etc. However, VERA stocktaking went beyond those activities, and we scanned also other international exercises such ESF's Forward Looks, similar activities by the Nordic Council, by energy organisations or other sectoral organisations, for example the WHO. In addition, the INCO networks VERA partners are affiliated with, helped with the stocktaking of FLA-like activities in various regions of the globe aside from the EU, for example, the Balkans, India, South-East Asia, etc. Exercises by a lot of governmental institutions such as the US DOE or public research organisations such as the French Cemagref/IRSTEA, the German Max-Planck-Society and Fraunhofer Society, the Finish VTT and many others with relevance to the ERA in recent years were taken into account, too. As part of this task, we conducted a serious of personal and phone interviews with experts on STI Foresight and FLAs to cover also countries which are not represented in the VERA consortium.

Geographically, the stocktaking had a focus on the EU and European countries but took a look beyond borders as well to get an outside view. While about one fourth of the reports focused on the EU in general, particular studies covered the UK, Finland, Germany, Czech Republic, Austria, Belgium, Greece, Denmark, France, Spain, the Netherlands, Ireland, Italy, Lithuania, Norway, Poland, Romania, Estonia, Slovenia, and Sweden. Beyond Europe, the US is covered in several reports, due to most of these reports having US origin. There were – though not prominently – many other countries covered in all world regions.

In the context of VERA, we took into account the different approaches and definitions for Societal Challenges and Grand Challenges, but at the same time we also wanted to free ourselves from predefined patterns of thinking. One such pattern is the "European approach" to societal challenges (JIIP 2012: pp. 11, 17), which considers SC to be key drivers of innovation and growth in Europe. We do not consider the economic nexus as a fix characteristic of our Societal Challenges approach. Rather the VERA Societal Challenges approach looked for Societal Challenges driven by societal demand, implying a mission oriented action toward coping with the Societal Challenges. Thus the first key characteristic of our Societal Challenges is that they are problem driven.

Secondly, the Grand Challenges we identified in VERA should also comply with several additional criteria. One of them is that their solution should be in the scope of public policy – eventually complemented by other societal efforts, but not completely out of the public policy sphere. The content of the Grand Challenges should also be of relevance for the ERA governance in general and represent the awareness of (at least some of) the Member States that this issue needs political action.

Further, the Grand Challenges should cease momentum and be of relevance for the mid- and long-term future. In fact, many FLA reports or policy papers deal with scenarios on what is going to happen, if an indicated alternative solution to a SC is implemented (positive) or if not (negative). Many take care of discussing potential changes of SC at national, transnational and global level. The scenarios usually make clear that the Societal Challenges (and their solutions) are of high impact and of high likelihood.

In the end, this lead to a set of 16 clusters of Societal Challenges. It is important to highlight that according to the above criteria, this constitutes the core set of SC in the perspective of the European Research Area, but we did not find an overall consensus about these issues, but rather a variation in the way they have been framed. In each country, in each cultural or societal context SC might be – at least slightly – different.

Table 1: Summary of Societal Challenges identified by the VERA project

No and Title of Societal Challenge	Short description
1 Uncertainty is arising from a multipolar world	Increasing polarisation and regionalization, emerging new economies and powerful multi-national companies are driving towards a multipolar world and a new world order. Possible evolutions and implications or for this challenge are still hardly understood.

No and Title of Societal Challenge	Short description
2 Values and attitudes are changing globally	Attitudes and values are changing globally, e.g. affecting consumer behaviours such as the turn towards value-oriented buying, ecological lifestyles, knowledge-based choice making or even frugality thinking. New innovation patterns such as "cradle to cradle" and locally oriented production patterns may foster different values, competencies and infrastructures such as for instance a new appreciation of traditional and local craftsmanship.
3 The traditional role of the state is challenged	The need for mediating between conflicting interests between the economy, environment and society and for reducing socioeconomic imbalances between geographic regions is challenging the traditional role of the state. Increasing demand for citizens' participation and transparency and the rise of non-state actors and the social divide in general, the erosion of trust in large institutions as well as in party politics and the call for personal responsibility and direct participation of civil society stress the need for new forms of governance and government.
4 The world is becoming more interconnected and thus more vulnerable	The more the world becomes interconnected and interdependent, the more new forms of crime and security threats are inter-linked and have far reaching consequences at all levels of society. In finding solutions to this challenge, action is required in the field of organised crime, cyber-crime and terrorism, without however putting privacy at risk.
5 Health concerns of an ageing society are rising	The ageing of populations has diverse implications on science, technology, economy, and society that are proliferated in the context of new health risks and ineffective health systems. Healthier lifestyles, prevention measures and new ways of integrating an aging work force into the formal or informal economy can help reap knowledge and experience gained.
6 A risk of financial system failure is emerging	The economic system is at risk of ongoing stagnation, financial crises, and uneven recoveries at worst facing the risk of major system failures. The volatility of financial systems is quite a complex phenomenon to handle. Furthermore, it puts the appropriateness of mainstream economic theories of development under question. This is turn makes efforts to find feasible solutions even harder and calls for radical thinking and transformation.
7 Current non-sustainable economic models come under scrutiny	A growing unease with the current model of economic growth calls for alternative approaches to societal progress on a macro-level. At the same time eco-consistent business models are required in all sectors of economic activity. Transformation towards sustainable or resilient life styles affecting also the economic production model could be one option.
8 Migration requires responses	The challenge of migration takes many forms as a consequence from other challenges like climate change, food and water shortages, natural disasters, pandemics, etc. each of which requires a specialized and coordinated response at various governance levels.
9 Education is struggling to cope with new demands	The education and training system in Europe needs to be modernized, a more specific demand defines the need for an education system capable of promoting sustainability, innovation and solidarity values at all levels while enlarging tertiary education among Europeans in general. Better skilled personnel are needed for the education of science and technologies.
10 The health situation in deprived regions is deteriorating	Impoverished regions around the world struggle with acute and virulent health issues. Outside the EU several deprived regions face precarious developments mostly rooted in poverty and adjunct to that mal- and undernourishment and the neglect of health provisions. While prospects are that absolute poverty will diminish over the next two decades, areas

No and Title of Societal Challenge	Short description
	of extreme poverty will remain, potentially entrenching existing gaps between rich and poor.
11 Climate change is causing new diseases	Global climate change has severe consequences on infections and diseases of humans and animals as well as plants and the entire flora. Accordingly, this development may affect food chains and again be a threat to human and animal health. Via food chains in related industries the consequences may lead to disturbances in global trade and businesses.
12 Providing basic resources for increasing global demands becomes difficult	Without ecologically, economically and politically sustainable solutions scarcities of basic resources such as food, water and energy may lead to extensive and serious social and political problems in some areas of the globe.
13 Scarcities in material resources are emerging	Science based solutions to respond to the growing demand for strategic minerals and metal or for their replacement seem insufficient. Europe's dependence adds to this critical condition (e.g. for gas) and make the region economically vulnerable. Many such resources are located in precarious regions of the world, often exploited by undemocratic regimes.
14 Our modes of energy supply and use are threatening the survival of humankind	CO_2 and other greenhouse gas emissions have caused the climate change phenomenon and related problems like vulnerability in nature, serious infections and other health effects, increasing natural disasters as well as the rise of environmental refugees due to increasing drought. Transition of entire energy systems towards sustainable direction in developed countries and large emerging economies is one of the key means for mitigating climate change.
15 Transportation systems come under strain	Environmental and health impacts from emissions, mitigation of climate change, urbanization, the need for traffic safety and security and avoidance of traffic jams are among drivers towards re-inventing mobility and full-scale transition of existing transportation systems. Systemic approaches for economically and ecologically sustainable solutions for European and global transportation are prerequisites for a major transformation in this area.
16 EU Competitiveness is endangered	Some sources reflect the fear of Europe falling behind other world regions in terms of competitiveness on the global market, issuing warnings that Europe may lose competitiveness due to poor education and skills as well as rising costs and declining labour force participation caused by demographic change. Another challenge is the fragmentation of Europe that may prevent effective exploitation of the research and innovation potential. Finally in a globalised world Europe will have to compete for the best brains with China, India, Turkey and Iran and may experience brain drain.

Societal Challenges are dependent from each other

This clustering of societal challenges shows that they are complex and calling for multi-faceted approaches to address them. This set reads **broader** than what has been identified as the common understanding of SC in Europe (JIIP 2012). It has a **more global** perspective, e.g. in the way it considers migration, impoverished regions, multipolarity and material resources, and it includes **more fundamental societal realms or principles** such as new values and lifestyles, the role of the state, the stability of public finance, the current economic model, education and EU competitiveness.

Moreover, there are many **interdependencies and dynamics** visible between the clusters. The following analysis starts off from thoughts provided in Giesecke et al. (2012, p. 37ff), but goes more into detail.

Centrality

Three clusters appear to be central or first-order ones as they are driving developments in several other realms:

- The cluster of providing **basic resources** for a population of nine billion individuals while preserving the ecosystem and balance with all other services expected from the ecosystem (SC no **12**) has several implications on other clusters of societal challenges, such as sustainable energy provision (SC no **14**) or dealing with material scarcities (SC no **13**). This has effects on the maintenance of transport systems (SC no **15**). More profoundly, this can lead to a deep societal transformation by adopting a sustainable economic model which underpins long term sustainable forms of production and consumption (SC no **7**). It might also drive conflicts and polarization around the globe (see below and SC no **1**), poverty (SC no **10**) and migration (SC no **8**).

- With values changing towards **new (ecological) lifestyles** and local specificities (SC no **2**), this has an important effect on how the role of the state (SC no **3**) is being seen (including potential consequences for security (SC no **4**)) or education (SC no **9**). It might also lead to further polarization or regionalization around the globe (see below and SC no **1**) or adopting a new economic model (see above and SC no **7**)

- The challenge of **ongoing financial crises** (SC no **6**) can appear to increase mistrust in public authorities and widely held beliefs in policy, which mean that the role of the state (SC no **3**) is in question as well as the "old" economic growth paradigm (SC no **7**). Also, European competitiveness might be endangered (SC no **16**).

Some societal challenges depend on trend developments with uncertain intensities. The more intense these developments unfold, the more urgent become these challenges.

- **Globalization** of the economy is such a development. This gives more power to globally acting firms (SC no **1**). The world becomes increasingly connected and thus more vulnerable to security threats (SC no **4**).

- Linked to globalization, there are trends of **polarization and regionalization** in the world. There is the expectation that new economic powers will emerge (SC no **1**). Some sources view this as a potential challenge to European competitiveness (SC no **16**). The rise of a multipolar world might also entail geopolitical consequences as well as new forms of crime and security threats (SC no **4**).

- **Climate change** is another development, which might unfold evolutionary, as a series of sporadic regional catastrophes or in its most severe form as a global climate crisis. In turn, societal challenges such sustainable energy supply and production (SC no **14**), better transportation systems (SC no **15**) and fighting new diseases of humans, animals and plants (SC no **11**) become central concerns. Furthermore, we can expect consequences for impoverished regions (SC no **10**), migration (SC no **8**) to Europe and for education (SC no **9**), where it will become key to focus in research and education on knowledge relevant for finding mitigation solutions to the climate effects. Similar to what was said above (cf. Basic resources), this can lead to a deep societal transformation by adopting a sustainable economic model which underpins long term sustainable forms of production and consumption (SC no **7**).

- **Demographic change** is another development of that kind. It is referred to in cluster no. **5** which points out the consequence of ageing societies and related problems of the health systems. Also the quality of transport systems (SC no **15**) is affected. It might at the same time drive new values, such as healthier lifestyles (see above and SC no **2**). In the form of a decreasing labour force it is also mentioned as one major force endangering European competitiveness (SC no **16**). There are also consequences for migration (SC no **8**) and education (SC no **9**) in Europe, although they are not made explicit in the short descriptions in the table above (cf Giesecke et al 2012).

Dynamics

Many Societal Challenges are sensitive to different drivers or developments as outlined in the previous section. This means that they might be perceived differently, depending on which driver will turn out to be dominant. For example, different drivers can cause a rethinking of the current economic model (SC no 7). If the climate change or the scarcity of basic resources is driving the development, in the most

extreme case a new collective orientation towards a sustainable society might emerge, replacing the jobs and growth paradigm. In case of changing values and lifestyles, sustainability might still play a role, but instead of a collective, central approach to it, local, individual solutions are pursued.

From the above listed SC and analysis, also these societal challenges might be perceived differently, depending on the central drivers:

- New forms of security threats (SC no 4)
- Health challenges (SC no 5, 11, 2)
- Sustainable forms of energy supply and production (SC no 14)
- Migration (SC no 8)
- Education (SC no 9)
- Transport systems (SC no 15)
- Poverty in the world (SC no 10)

Why societies might perceive some societal challenges more central to others, will depend on their urgency and on the degree local affectedness.

Implications for scenario building in general and in the VERA project

The findings from the analysis of Societal Challenges have several implications for scenario building:

- We cannot take a definition of Societal Challenges for granted. The observed variations and interdependencies give evidence to the time-dependence and geographical dependence of understandings of societal challenges.
- Societal Challenges become a major factor of differentiation between different futures in general and different STI scenarios in particular.
- Therefore, VERA is not about building a consensual view of the future, but about developing profoundly different future scenarios – an exercise which shall serve in the end to look for issues we need to prioritize today.
- To develop extreme and diverging scenarios, a factor approach was employed, where a wide range of available sources were scanned to identify key factors. The identification and clustering of societal challenges as described above was one major source in this process (cf. Teufel et al. 2013).

How societal challenges shape the VERA scenarios

VERA has developed "outside-in"-scenarios, starting from global and European drivers, external to R&I by 2030 and considering ERA internal dynamics in a second step. Although only the title of scenario 2 gives a clear reference to societal challenges ("**Societal Challenges – Joint Action** ", see table 2 below), societal challenges have played a major role as external drivers in all scenarios.

We assume first – in line with the analysis outlined above – that some challenges are driven by trend developments. These macro trends, such as globalization, a multipolar world or climate change, are assumptions shared by all VERA scenarios with only slight variations in the emphasis given to them.

Secondly, two drivers play a key role in the move towards one scenario or the other (see for the following also table 2 below and for further details VERA project 2014 and Robinson et al. 2014).

- The principal values and paradigms of society / the model for societal progress:
  - The paradigm might be about jobs, growth and competitiveness like it is today. This is the assumption underlying scenario 1 (Private Knowledge – Global markets) and scenario 2 (Societal Challenges – Joint Action). So, in both scenarios, actions which address challenges are driven by economic considerations in the first instance. In scenario 1 this is because mainly private actors or public-private-partnerships provide the financial basis of activities in search for solutions to challenges. In scenario 2, joint actions appear to build on existing strengths of European regions, such as existing infrastructures and (sectoral) clusters. (Subordinate) Societal Challenges likely to be addressed in these two scenarios are detailed in table 2.
  - VERA scenarios 3 and 4 correspond to two types of transitions: towards new definitions of progress ("human well-being" in scenario 3 and "sustainability" in

scenario 4) and correspondent RTDI governance. How these transitions to new paradigms shape the perception of (subordinate) Societal Challenges is presented in more detail in table 2.

- The role of the public finance crisis in scenario shaping:
  o We have built two scenarios that assume Europe has the financial ability to address proactively the 'Societal Challenges' it has identified: scenario 2 makes a balanced effort between different Societal Challenges, while scenario 4 concentrates on the ecological transition.
  o The two other scenarios take place in a constrained environment for public expenditure: scenario 1 recognises it and gives economic actors a wide responsibility in shaping directions, while scenario 3 corresponds to a fragmented search for solutions and the rise of local and regional answers.

Table 2: How societal challenges shape the VERA scenarios

VERA Scenario	Societal Challenge(s) acting as driving force(s	Perception of subordinate Societal Challenges
1 Private Knowledge – Global Markets	In this scenario, the after-effects of the **global financial crisis** of 2008 are still deeply felt. (SC no **6**) As a consequence, the variety of approaches to recovery has led to locked-in growing inequalities between countries and regions within the European Union. So, the recovery from the crisis, a new period of growth and the creation of jobs are the thrust driving political and private action.	The **role of the state** (SC no **3**) is challenged: private actors spending large amounts on R&D and setting de-facto research agendas. European competitiveness has been regained – this SC (SC no 16) is overcome by 2030 in this scenario. The "old" economic growth paradigm (SC no 7) is still in place; not questioned in this scenario. **Other SC: Managing energy transition (**SC no **14) and health (**SC no **5, 11)**
2 Societal Challenges – Joint Action	The sense of urgency has been the driving force of this scenario. Various causes are behind this sense of urgency, among them a **shortage of energy provision (**SC no **12), military conflict right on the borders of the European Union (**SC no **1), and alarming developments as regards climate change or disease pandemics (**SC no **11)**. To maintain the way of life in Europe, European States have become increasingly open to collective action. This is accompanied by recovery from the 2008 financial crisis (no 6 as a SC has been overcome).	Societal Challenges addressed are: Security and sustainability of **energy provision (**SC no **14**), **Health** issues (e.g. pandemics, prevention, SC no **11**), and other effects of **Climate Change, e.g. sustainable transport (**SC no **15**) The "old" economic growth paradigm (SC no 7) is still in place; not questioned in this scenario. There is a regionalization trend in this scenario with hot spot regions in Europe and around the globe becoming economically stronger, thus also increasing **polarization between regions (**SC no **1**). This and new forms of **crime and security threats (**SC no **4**) might be perceived as SC, too.
3 Solutions apart – Local is Beautiful	Major political scandals, in particular data scandals, and the inability of policy to cope with the **lasting financial crises** (SC no **6**) have spawned a rapid growth of **mistrust in higher level policy making (**SC no **2**). This has been speeded up by **social movements** supported by widespread internet use.	The inability to collaborate leads to a local handling of societal challenges and a **reduced role for public** – in particular higher-level – **authorities (**SC no **3**). This also means that the **economic model of jobs & growth has been replaced** by the pursuit of solutions which benefit the municipality and its citizens (SC no **7**). Issues addressed (as they are in fact not being debated as societal challenges) are: **Smart cities** (incl. the aspect of high quality **transport,** SC no **15**), **local energy production (**SC no **14**), public **health** and prevention

VERA Scenario	Societal Challenge(s) acting as driving force(s	Perception of subordinate Societal Challenges
		(personalized medicine, cf. SC no **5 and 11**), **local food productio**n and distribution systems (SC no **12**) and **ICT (cyber-security,** SC no **4)** Issues outside of Europe are of less concern.
4 Times of Crises – Experts at the Wheel	The driving force of this scenario is the onset of dramatic climate catastrophes with important effects on the environment and eventually our health and way of life. These disruptive forces are levers of deep societal transformation. As a consequence, the **growth paradigm is completely replaced by a new sense of "deep sustainability" on which all economic, political and societal activities are based (**SC no **7)**. The full recovery from the economic and financial crises of the early years of the Century supports these developments (SC no 6 as a SC has been overcome).	Under the overarching goal of mitigation and adaptation to the effects of the climate crisis, several other challenges are addressed, including **urban management**, **energy provision (**SC no **14**), **new forms of housing and mobility (cf transport** SC no **15**), **food production and circulation (**SC no **12**), and **Health (**SC no **11**). There are programmes for **impoverished regions** (SC no **10**), and **migration** (SC no **8**); and a re-orientation in **education** (SC no **9).**

Note: Numbers in parentheses refer to the numbers used in table 1.

4   Conclusions

There is few doubt that Societal Challenges (SC) are increasingly important determinants of policy in general and of Science, Technology and Innovation Policy in particular. Addressing them requires commitments and investments of societies not only short-term, but rather mid- to long-term. As such SC become important drivers of Forward-looking activities.

In the perspective of Europe and the European Research Area, SC are quite central, constituting one important pillar of Horizon2020. Whereas it seems that there is currently a common understanding in place about the scope and characteristics of SC, we have attempted to show in this paper, that the understanding of SC may vary. Looking at the current US debate for example, we see that there are differences to the European debate.

In the context of the VERA project we have scanned Societal Challenges in existing EU documents and discussion papers that were published and discussed in related foresight and horizon scanning projects. Allowing for such a broader approach with the aim to identify what might be important challenges for a future European Research Area, we can characterize the resulting set of 16 SC clusters in the following way: It has a more global perspective, e.g. in the way it considers migration, impoverished regions, multipolarity and material resources, and it includes more fundamental societal realms or principles such as new values and lifestyles, the role of the state, the stability of public finance, the current economic model, education and EU competitiveness.

In fact, not linking the prioritization of SC to economic growth as the "European approach" does today (JIIP 2012), broadens the understanding of SC considerably (cf also Weber/ Daimer 2014). In light of foresight work, these kinds of more profound societal changes and challenges seem to be of high relevance. As we have shown in the analysis, there is a strong dependency between these central Societal Challenges and other SC, which in turn appear to be subordinate. So, depending on which SC societies might perceive more central to others, societal and political efforts might vary considerably.

Using the scenarios developed in the VERA project, where we interested in the future of Research and Innovation and its governance in Europe by the year 2030, we can illustrate how the different emphasis on central societal principles and challenges affects the perception of other (subordinate) SC. Furthermore, this is not neutral to policy and governance. Quite different models of setting societal (and hence research) priorities and of organising the solutions, e.g. linking science to other sources of knowledge are fleshed out in the VERA scenarios. By way of this, Societal Challenges become important shapers of profoundly different STI (governance) futures.

One interesting result is that in the VERA scenarios SC do give necessary but not sufficient momentum to joint European Action. We project futures, in which SC are being dealt with at global or local level.

- Joint action might be the result of a catastropic event, such as a climate catastrophe, see scenario 4 (Times of crises – Experts at the Wheel).
- Joint action might be the result of societal or political events creating a sense of urgency, see scenario 2 (Societal Challenges – Joint Action). Still, the evolution of joint action in that scenario requires mechanisms of democratic debate and legitimation, which is why it is assumed that European joint action will not remain at the level of intergovernmental cooperation, but instead become subject to parliamentary oversight.
- In case of events weakening natonal level or European level governments or governance structures (i.e. because of severe financial constraints or events sowing mistrust such as big data scandals), joint action might only appear in a few instances and rather at global scale, such as private-driven joint action (e.g in PPPs or large philantropic efforts, see scenario 1 (Private Knowledge – Global markets)) or such as local or regional approaches to solutions, see scenario 3 (Solutions apart – Local is beautiful).

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