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Towards Transformative Innovation Priorities

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Purpose

This brief synthesises the findings of forward-looking activities that were recently carried out in different European countries with a focus on research and innovation. In order to structure the activities' outcomes, a framework is used that distinguishes different types of outcomes. The findings of the activities are then presented along this framework. The last section suggests some conclusions for European-level, challenge-driven research and innovation priority setting. The study was conducted for the expert group Global Europe 2030-2050 http://ec.europa.eu/research/social-sciences/fwl-experts-groups_en.html and financed by the European Commission's Social Science & Humanities Programme.

National Innovation Priorities Addressed

The countries in focus were France, UK, Germany, Spain, Poland, Finland, Ireland, Luxemburg, the Netherlands and the region of Flanders. All nine activities adopted forward-looking methods for a structured assessment of possible pathways for research and innovation. All activities were based on intense involvement of experts and stakeholders with diverse backgrounds. Some adopted very large-scale participation and reached out to broad publics (FORSK2015, NL Horizon Scan); others were more confined to core actors with specific expertise (UK TIF, T&I Flanders, BMBF Foresight). Moreover, some of the activities aimed at generating possible pathways of change within a certain time horizon or even pursued fully fledged country scenarios, as in the case of Poland and Ireland. Others were more interested in scanning signals pointing towards relevant changes (Foresight.fi, NL Horizon Scan), and again others sought to collect and assess a wide range of proposals for re-

search and innovation (R&I) topics (FORSK2015, FNR, ClésTech).

While some of the activities focused on assessing technological trends (ENCYT2020, T&I Flanders, ClésTech) others adopted a very broad perspective on up-coming socio-economic change and its consequences for research and innovation (France 2025, Poland2020). Other activities put particular emphasis on linking established realms of research and innovation, on the one hand, and areas of need and problems in new future-oriented ways (BMBF-Foresight, NL Horizon Scan).

With this rich diversity of approaches, all selected activities have one ultimate goal in common: defining a research and innovation agenda that best addresses future needs. Most of the activities used a set of criteria for assessing RTI topics composed of global challenges, on the one hand, and national objectives, on the other. Thus, the synthesis may well provide valuable insights on the challenges ahead when orienting research and innovation towards the grand societal challenges of our times, as envisaged in the European Innovation Union Initiative.

Categorising Future Research & Innovation Priorities

In the synthesis the categories will be used as follows:

Research and innovation topics: Specific topics for research and innovation assessed as highly future rele-

vant and therefore to be prioritised. Due to the nature of the activities, these topics usually stem from engineering and natural science realms. Example: Metamaterials (UK TIF).

Application domains: Domains and sectors where significant applications of the technology and innovation areas are expected. Example: Transport (ENCYT, UK TIF).



Socio-economic change signals: Changes in society and economy assessed as highly relevant for priority setting in research and technology innovation (RTI). Example: New forms of ownership (Foresight.fi, UK TIF)

“Grand Challenges”: Major challenges for society expected to drive the research and innovation agenda in the future. Example: Need for preservation of ecosystem services (FORSK2015, FNR)

Crosscutting priority areas: Proposed RTI focus areas linking several elements out of the four previous aspects. Example: Manufacturing on demand (UK), ProductionConsumption2.0 (Germany)

Some activities contribute in depth to one of the categories; others address two or more aspects as illustrated in Figure 1.

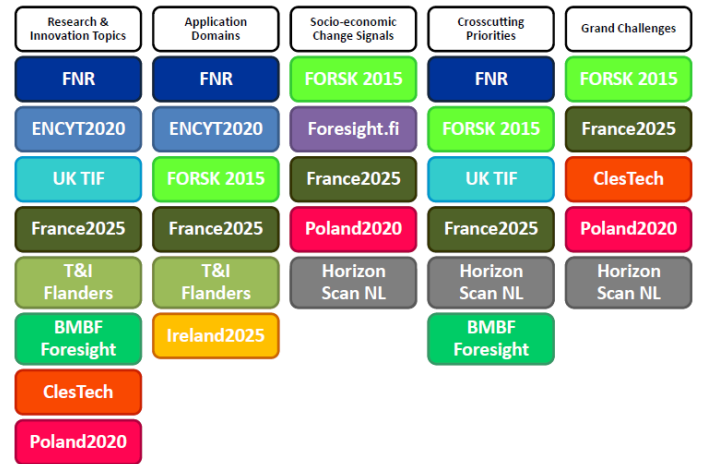


Figure 1: Main contribution of the studies

Converging Topics

Despite national specificities and differences among the countries, a certain convergence of R&I priorities can be observed. Topics related to energy transition as well as sustainable patterns of production and consumption are high on the agenda of several countries followed by health related topics and information and communication technologies.

Signals of Socio-economic Change

A number of the activities emphasise socio-economic change as a key element of the innovation arenas. In particular, several activities point out the need to explore new forms of identity-forming, cultural diversification and community building to understand successful innovation pathways.

The Foresight.fi blog specifically considers changes in socio-economic patterns as a core part of research and innovation futures. Issues such as changing attitudes towards product ownership, identity formation, self-expression, changing innovation patterns, new concepts of work, new types of jobs, new work and communication attitudes, open data, open science, new growth models, information ownership/control are discussed at some length and seen as relevant drivers not only for society overall but also for the direction of technological innovation. Another study that considers

socio-economic innovation in depth is the NL Horizon scan. Some of the proposed priority topics explicitly address socio-cultural research, focusing for example on the socio-cultural meaning of an aging population. Another cluster is dedicated to new forms of work and education. Two other topics deal with global political and economic changes. The UK TIF study deals in depth with intellectual property rights as an area of innovation in its own right.

Furthermore, the following areas of socio-economic change are mentioned as relevant for the research and innovation fields in at least three activities:

- Values, lifestyles, behaviours, determinants of choices, in particular of coming generations
- Social fabric (age, culture)
- Patterns of consumption/use
- Value creation patterns, business models
- Conception of humanness
- Economic patterns, growth models
- Work/life patterns
- Modes of governance
- Public sector, transparency, open data
- Science-society interaction, citizen participation
- Modes of communication and trust building
- Leadership challenges

Application Domains

The domains where the innovations are expected to be applied are similar in all activities. Across activities, there is a striking emphasis on food and agriculture, both in terms of security and safety and as a key aspect of environmental sustainability and culture. The other two top innovation target areas are energy and transport followed by health, housing, communication, education, public administration and security.

Some national differences can be clearly identified. France, for instance, is putting strong emphasis on agriculture whereas Luxembourg is focusing on multimedia and service innovation. Germany is innovating along traditional production paradigms whereas the UK is pushing innovative manufacturing technologies in combination with new service and business concepts. Finland is especially concerned with the future of the countryside.

“Grand Challenges”

Most of the activities did not explicitly attempt to define the grand challenges driving research and innovation activities but rather adopted them from well-known documents such as the Millennium goals. In one case (Ireland), competitiveness of national industry was used as the only relevant criterion, but also several other national activities chose technology and innovation areas with a strong emphasis on securing advantages over competing economies.

However, most activities saw the need to address global challenges as an important rationale for RTI priority setting and adopted a mix of selection criteria combining competitiveness and challenge-oriented criteria.

The following societal challenges are explicitly mentioned as drivers for RTI priority setting:

- Energy (securing energy supply and decarbonising energy production through new sources and efficient use)
- Counteracting climate change
- Preserving biodiversity
- Food safety and security
- Preserving ecosystems services/securing a clean environment
- Adapting to climate change
- Securing water supply
- Combating chronic and infectious diseases
- Handling global conflicts
- Understanding and dealing with changes in social fabric, in particular demographic change but also diversity
- Ensuring well-being and quality of life
- Ensuring resource security

Towards Socio-technical Breakthrough

None of the activities highlights one particular technology area as likely to yield radical breakthrough innovations in the near or mid-term future. However, most activities aim towards breakthrough transformations in key innovation arenas through alignment of innovations from technological and socio-economic realms in order to achieve change in addressing societal challenges. By definition, such *trans-*

formative priorities require research across engineering, natural and social sciences as well as the humanities, as they target aligned social and technological breakthrough innovation rather than just isolated technological change.

The synthesis offered here focuses on the most striking convergences within the national foresight activities. Accordingly, the transformative priority arenas outlined below are far from covering all relevant topics for research and innovation identified by the activities.

	Key approach	Related national R&I priorities	Social innovation aspects
Energy transition	Developing competitive, energy efficient and sustainable energy systems that can satisfy future energy demands and environmental requirements	Crosscutting: Accelerating the development of new energy sources; the energy transition; energy systems of the future; energy mix Specific: Energy generation, storage, distribution (and respective technologies); understanding and modelling human behaviour; service innovation	
Bio-resource management	Sustainable management of bio-resources for food, health, energy and materials	Crosscutting: Bio-resource-based production; Production-Consumption2.0; sustainable resource management Specific: Agricultural technologies; industrial biotechnology; understanding and modelling human behaviour	
Sustainable patterns of production and consumption	Transformative innovation towards sustainable patterns of production and consumption	Crosscutting: ProductionConsumption2.0; manufacturing on demand; local cycles Specific: Production technologies and concepts; complexity and systems thinking; understanding and modelling human behaviour; service innovation; green housing; new forms of collaboration; hybrid (product/service) value creation	Values, lifestyles, behaviours; determinants of choices, in particular of coming generations; patterns of consumption/use; value creation patterns; business models; economic patterns; growth models; work/life patterns; science-society interaction; citizen participation
Human-technology continuum	Exploring new high-quality modes of human-technology interaction	Crosscutting: Robotics and interconnectivity; human enhancement; human-technology cooperation, Internet revolution Specific: Lab-on-a-chip/bio-electronics; performance enhancers; brain modelling; brain-computer interface; omics; intelligent sensor networks and ubiquitous computing; multi-sensory input; service and swarm robotics; searching and decision-making; secure communication; trust; surveillance; semantic web; remote/virtual services; service robotics; assistive systems; cognitive prostheses	Changing values, lifestyles, behaviours; social fabric (age, culture); conception of humanness; work/life patterns; modes of communication and trust building
Infrastructure transition	Pathways for sustainable infrastructure transition (transport, energy, housing and water)	Crosscutting: Sustainable transport and infrastructures; smart infrastructure; infrastructures for the future Specific: Transport technologies; smart grid; service innovation; human behaviour; next generation networks	Values, lifestyles, behaviours; determinants of choices, in particular of coming generations; work/life patterns
Living spaces	Sustainable patterns of rural and urban living spaces	Crosscutting: Better lifespaces – space for life and growth (DK); Two related transitions: Creating and utilizing space (NL); Sustainable living spaces (DE); Countryside and local cycles (FI); Cite2020 (F) Specific: Sustainable construction materials; green/smart housing; service innovation; human behaviour; agricultural technologies	Values, lifestyles, behaviours; social fabric (age, culture); patterns of consumption/use; work/life patterns; science-society interaction; citizen participation; modes of communication and trust building

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Conclusions for the Innovation Union

The transformative priorities emerging from the national forward-looking activities outlined in the previous section directly link with the “grand societal challenges” addressed in the Lund declaration and the Innovation Union initiative. Moreover, they are perfectly in line with the Innovation Partnerships proposed by the Innovation Union Flagship, both in terms of set-up and content. In particular, the areas Smart Cities and Smart Mobility as well as Agricultural Sustainability outlined by the Commission Communication fit well into the framework presented in this paper. But also the challenge-driven approach, the strong role of social innovation and the need to go beyond the “technology focus of the existing instruments” fit with the Innovation Union approach.

Transition Arenas Must Not Be Isolated

Several of the societal challenges are closely inter-linked. It is obvious that the evolution of living spaces is closely tied to the underlying infrastructures and energy sources, which again co-evolve with the patterns of production and consumption. Therefore, the transition arenas cannot be easily separated. Optimising one aspect without taking into account the other is bound to fail, as several activities point out using the example of potential conflicts of biodiversity and bio-resource use.

Cultural Diversity Matters

Although several activities converge around certain socio-technical breakthrough arenas, the meaning is still different in each cultural context. This is obvious in the case of the living spaces of the future. Even though

some countries have proposed almost identical priorities, the main concerns behind these propositions differ: The Fins are very much concerned with life in the countryside as a key element of their culture; the Dutch in turn expect to free space by changes in agricultural use and think of new possibilities for making good use of scarce space; the French focus is on the future of agriculture and food quality whereas the Germans, with their recent experience of shrinking cities in Eastern Germany, are considering flexible spaces to adapt to changing life-styles. Similar observations hold for all other transition arenas. Accordingly, when acting at the European level, “normalising” national diversity into one-size-fits-all approaches is bound to fail. The rich diversity needs to be kept as a particular strength.

Defining and Implementing Transformative Priorities Requires Participatory Processes

Transformative breakthrough priorities, as suggested here, are not a purely a matter of science and technology but involve substantial social and cultural innovation. Accordingly, they cannot be addressed through research alone but require aligned social and technological experimentation. This again cannot be enforced by top-down priority setting in the realm of science and technology. Participatory processes involving not only researchers and engineers but also European citizens are needed to define the adequate designs for these experimental spaces. The activities investigated here give some indications how this could be done, also at the European level. In particular, the Netherlands Horizon Scan and the Danish Forsk2025 seem to offer feasible routes for orienting research and innovation in society and technology towards shared goals by a creative and participatory linking of problems and solutions.

Sources and References

National forward-looking activities covered:

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Luxemburg: FNR FNR FORESIGHT – THINKING FOR THE FUTURE TODAY. <http://www.fnrforsight.lu/>

Netherlands: NL Horizon Scan: Horizon Scan Report 2007: Towards a Future Oriented Policy and Knowledge Agenda

About the EFP: Policy professionals dealing with RTD, innovation and economic development increasingly recognize a need to base decisions on broadly based participative processes of deliberation and consultation with stakeholders. Among the most important tools they apply are foresight and forward looking studies. The EFP supports policy professionals by monitoring and analyzing foresight activities and forward looking studies in the European Union, its neighbours and the world. The EFP helps those involved in policy development to stay up to date on current practice in foresight and forward looking studies. It helps them to tap into a network of know-how and experience on issues related to the day-to-day design, management and execution of foresight and foresight related processes.