

Forward-Looking Activities and STI Policies

EU-SPRI 2020 Conference Track – substitute online session

Friday, 5 June 2020, 9:00 – 12:30 (CEST – Central European Summer Time)

@ GoTo Meeting <https://global.gotomeeting.com/join/786612053>

Programme

Time	Author(s)	Title
9:00 – 9:05		Short introduction to the session
9:05 – 10:30	Michael Keenan	The OECD STI Outlook 2020
	Nadezhda Mikova, Heike Brugge, Wofgang Eichhammer and Ewa Dönitz	European energy scenarios 2050: how new social trends may influence future energy consumption in European countries
	Lisa Nabitz and Dirk Scheer	Narratives in the future discourse on synthetic fuels – a stakeholder-focused content analysis
10:30 – 10:45		Break
10:45 – 12:15	Dirk Scheer and Lisa Nabitz	The policy package approach: elaborating ex-ante knowledge for policy advice through inter- and transdisciplinary assessment
	Ernesto Andrade- Sastoque, Gonzalo Ordonez-Matamoros and Stefan Kuhlmann	In which (participatory) ways could sociotechnical imaginaries enrich innovation policy instruments for them to be transformative in extractive economies
	Attila Havas and K. Matthias Weber	Take or shape: Policy governance modes to address transformation processes
12:15 – 12:30		General discussion

Submitted abstracts

Michael Keenan, **The OECD STI Outlook 2020**

From climate change to population ageing to far-reaching geopolitical adjustments, the world is facing unprecedented changes marked by uncertainties and unknowns. While there is untapped potential for research and innovation to address these trends, the pace of technological change adds to the uncertainty and makes policy oversight of emerging technologies increasingly difficult.

The OECD is looking 10-20 years into the future on selected topics related to research and innovation policy, using its Science, Technology and Innovation (STI) Outlook as a discussion platform. The STI Outlook reports on the latest trends and issues relevant to science and innovation policy. It also serves to showcase the OECD's science and innovation policy work and to explore new topics that might be covered in future projects. In a time of rapid change and high uncertainty, responsible policy-making requires identifying and preparing for new and unexpected developments. An important source of the STI Outlook's value added is its forward-looking analysis and its potential to synthesise various strands of work and opinion.

The STI Outlook 2020 has six broad themes: Technology governance; Sustainability transitions and missions; Human resources for R&D and innovation; Financing of R&D and innovation; Digitalisation of science and innovation; and Next generation data and analytic tools for STI policies. The topics covered include the research precariat, mission-oriented innovation policies for the SDGs, funding for high risk / high reward research, and the ethics and global governance of emerging technologies, to name but a few.

The STI Outlook leverages various types of content developed across multiple lines of activity, including thematic OECD project work, statistics, and country policy data in the STIP Compass. This content is being 'stretched' through forward-looking analysis that offers additional perspectives and insights. This includes desk work on megatrends and technology trends, and a survey of 300+ OECD committee and working party delegates (from national ministries) on their expectations for the future. The time horizon is generally in the 10-20 years range, though can be longer or shorter, depending on the issues being analysed.

The STI Outlook has a dual format: by April 2020, a dedicated website will have been launched featuring various types of content, including thematic and country analysis, drawing on statistics, qualitative policy data analysis, and opinion pieces. This is being updated throughout the year as new content becomes available, and acts in part as a structured repository. Then in November 2020, a book will be published containing the STI Outlook's main findings and messages.

EUSPRI offers an excellent opportunity to collect a wide range of views and ideas on future science and innovation developments that could feed into the STI Outlook 2020. Accordingly, this speed talk aims to inform the EUSPRI community of the STI Outlook's approach and emerging findings and to elicit expert analyst views on future directions of change that are likely to have major impacts on the scope and practice of STI policymaking and analysis over the next decade.

Nadezhda Mikova, Heike Brugge, Wolfgang Eichhammer and Ewa Dönitz: **European energy scenarios 2050: how new social trends may influence future energy consumption in European countries**

New societal trends are currently unfolding, such as digitalisation, sharing economy and changing consumer awareness. These trends, not accompanied by policies with a strong implementation of the Energy Efficiency First (EE1) Principle, might highly influence future energy demand and depending on their realisation might enhance or counterbalance projected energy efficiency gains. This work is a first attempt to analyse quantitatively how these societal trends might interact with energy efficiency. An extensive consultation with European experts identified 14 new societal trends that are likely to shape future energy demand. Based on these trends, three energy demand scenarios were developed for 2050 (“Removing Barriers”, “New Trends Efficient” and “New Trends Inefficient”) in addition to the EU “Baseline” scenario. Through extensive review of existing studies as well as expert consultations the impacts on all sectors were evaluated in two additional scenarios taking explicitly these trends into account. This paper aims to open up the discussion of how new societal trends will shape future energy demand. It explicates that solely relying on unregulated energy efficiency gains to reduce energy demand underestimates the complexity of the interplay of energy demand with changing behaviour through societal trends, while they may also bring about large reduction potentials.

Theoretical background

The research related to the influence of new societal trends on energy consumption have been done in academic literature (f.e. Wadud et al., 2016; Pfaffenrot, 2017; Hamari et al., 2016; Urbach and Röglinger, 2019; Walter and Sillanpää, 2018; Debref, 2018) and in practical projects (f.e. European Commission, 2010a; European Commission, 2010b; European Commission, 2011; IEA/OECD, 2017; UKERC, 2011; European Commission, 2017; EU Calc, 2017; Material Economics, 2018; Öko-Institut e.V. / Fraunhofer ISI / IREES GmbH, 2016; Ricardo, 2017; European Commission, 2010c; European Commission, 2018; BAMB, 2016).

Nevertheless, a more systemic approach investigating the influence of new societal trends on energy efficiency in different sectors is needed to be developed. This approach should be based on the combination of qualitative and quantitative methods providing the comparable figures and estimations.

The main goal of this paper is to identify new societal trends that will shape future energy demand in European countries and analyse quantitatively how they might interact with energy efficiency gains in different sectors.

The main research question of this paper is:

How new societal trends may influence energy demand and energy efficiency in different sectors in the European countries by 2050?

The results of this study may be of interest for policy makers, business representatives and academic community, involved in activities and research related to exploring the role of new societal trends in future development of energy sector.

Methodology

The methodological approach of this study includes the following working steps:

Step 1: Trend identification

The trend identification departed from a study from VDI-Technologiezentrum and Fraunhofer ISI (2017) for the German Federal Ministry of Education and Research (BMBF), in which a set of megatrends and detailed trend profiles was developed. The trend selection process – from 84 trends (60 societal trends and 24 megatrends) to 12 trends identified to be particularly relevant for the energy demand and the implementation of the EE1 Principle – was based on expert discussions including clustering of similar themes, so that the trends had similar levels of aggregation.

Step 2: Deep dive analysis

A deep dive analysis was carried in order to assess the relevance of the societal trends for the energy system. The implications for the increase or the decrease of energy efficiency and energy demand were discussed and the specific indicators of change (key parameters) were identified.

Step 3: Expert discussion

The (energy-relevant) megatrends and trend profiles were selected in an expert workshop. 12 new societal trends were identified to be particularly relevant for the energy demand and the implementation of the EE1 Principle. These 12 trends were further clustered into 4 main societal trend clusters, which formed the basis for the scenario work: “Digitalisation of life”, “New social and economic models”, “Industrial transformation” and “Quality of life”.

Step 4: Scenario development

Steps 1 to 3 have focused on the identification of the most relevant societal trends for the energy systems in general, particularly for the increase or decrease of energy efficiency and energy demand. Step 4 focused on the analysis of the impact of societal trends on the modelling parameters and the scenario development.

Under expert consultation 3 scenarios – beside the baseline – and one variant up to 2050 were developed:

S1. “Removing Market Barriers” (or “Techno-Economic”)

S2. “New Trends Inefficient”

S2.1. Variant – “Worst Case”

S3. “New Trends Efficient”

Results

The main findings from this research are the following. First, in the “Baseline” scenario the decrease in final energy demand until 2050 is small (-6% compared to 2010). Second, with the realisation of techno-economic potentials (“Removing Market Barriers” scenario) a quite important decrease of final energy demand is possible (-51% compared to the “Baseline” in 2050). Third, new societal trends without EE1 (“New Trends Inefficient” scenario) could diminish the effect of the realised techno-economic potentials for final energy demand to a 32% reduction. In this case, the new societal trends, if not counteracted by a strong EE1 Principle, could even increase energy consumption up to 42% compared to the present “Baseline” (“Worst Case” variant of the “New Trends Inefficient” scenario). Fifth, new societal trends supported by a strong EE1 Principle (“New Trends Efficient”) could decrease final energy demand further (-67% compared to the “Baseline” in

2050). Finally, the gross inland consumption and the (energy-related) GHG emissions follow these trends closely.

Conclusion and policy implications

Efficiency gains play a crucial role in realising the EU climate goals. However, these efficiency gains do not by themselves lead to a reduction of energy demand. For example, as the transport sector has exemplified over the last years, the potential reduction of energy demand by increasing efficiency is counterbalanced by an ever growing demand of private car transport and larger vehicles. This paper aims in opening up the discussion of how energy demand might change through new societal trends. Based on these trends, it analyses three energy demand scenarios developed for 2050 (“Baseline”, “Removing Market Barriers”, “New Trends Efficient”, “New Trends Inefficient”). As the various scenarios depict in a stylised way, new societal trends could unfold in a way that further decreases in energy demand beyond merely realising the techno-economic potentials, if the EE1 principle guides individual and policy decision making in a beneficial way. However, the effects of the new societal trends could also counterbalance efficiency gains in a way that leads further away from the achievement of the EU goals.

The results of this study show, that the path that final energy demand will take in the years to come is less than certain and will depend not only on the realisation of techno-economic potentials but to a vital part on how societal trends will unfold. These trends can have an impact on energy efficiency improvements and contribute to decrease or increase of energy consumption beyond the linear trends. In particular, an increase in energy consumption might be the result of new societal trends that are not accompanied by policies with a strong implementation of the EE1 Principle. It will thus be crucial to further intensify the work on studying not only the cost-effective potentials but also to further quantify the effects that societal trends will have on future energy demand. This might ultimately inform policy makers on how the European policies have to be designed in order to shape political, commercial and individual decision-making in a way that further decreases energy-demand rather than counterbalances efficiency gains.

Lisa Nabitz and Dirk Scheer: **Narratives in the future discourse on synthetic fuels – a stakeholder-focused content analysis**

The transformation of the energy and transport system towards climate protection is a task for society as a whole that needs the support of all relevant groups, stakeholders and consumers. Especially the transport of passengers and goods driven by fossil fuels contributes significantly to climate change through CO₂eq emissions. In the endeavour of decreasing CO₂eq emissions, refuels – as one building block – play a significant role as the predominantly used gasoline and diesel fuels may as well be produced as renewable fuels (refuels) from non-fossil carbon sources such as biogenic residues in combination with direct conversion of CO₂eq and renewable hydrogen production including subsequent synthesis processes.

Even if there is fundamental agreement between different stakeholders on the goal of the energy transition as a whole, regarding the Verkehrswende (transition in the transport sector) and in particular regarding refuels, stakeholders set their own and sometimes opposing accents in their positioning. This refers in the storytelling for example to divergent opinions about where and from which energy the synthetic fuels are made or which political framework and policy instruments are necessary for the diffusion of refuels in the market. Against this background, the aim of this analysis is to systematically identify, record and analyse the diversity of stakeholder perspectives in Germany using a document-based position analysis in order to provide the broadest possible range of (controversial) positions and evaluations on the refuels' future path. On the basis of a document analysis of 41 sources published by 18 stakeholders from the areas of economy (8), environment (4) and civil society (6) in the last ten years, we analyse commonalities and differences in the assessments of the refuels' path as well as the reasons behind it. We thereon derive comprehensive narratives and conclusions regarding relevant dimensions such as the overall potential of refuels in the context of the energy transition, areas of application, type of energy production, timeline, possible trade-offs regarding water and land availability, political framework and others. The results may allow policy makers to recognize impending acceptance conflicts early on and to take appropriate planning, design, participative or communicative measures.

The analysis presented here is part of a research project called refuels – re-thinking fuels funded by the State Government of Baden-Wuerttemberg and represents the first step of a broader stakeholder analysis. The document-based research will be further complemented by interviews and expert workshops in order to supplement and verify the data.

Dirk Scheer and Lisa Nabitz: **The policy package approach: elaborating ex-ante knowledge for policy advice through inter- and transdisciplinary assessment**

The transformation of the energy system has become a high-ranking priority on the political agenda in many countries. In response to climate change challenges, main emphasis is on transitioning the energy system from high to low carbon energy supply. General principles of energy policy targets yield towards paradigms of affordability, security of energy and sustainability. For designing adequate policy options and framework settings, policy- and decision-makers in general rely on scientific policy advice. As a new approach, policy packaging aims to extend the toolbox for delivering adequate policy advice. Within the Kopernikus Project “ENavi - Energiewende navigation system”, an approach is developed that elaborates adequate policy packages for climate friendly energy transitioning. In a second step, these packages run through inter- and transdisciplinary assessment, evaluation and discourse processes in order to gather ex-ante knowledge on policy package consequences and effects, trade-offs and unintended side-effects, pros and cons, and redesign options. The presentation offers first results and insights on methods of synthesizing and elaborating coherent policy packages, and applying this approach in the field of urban mobility transition.

The perspective of systemically structured policy packages stands for the idea that there is a need for combined interventions and measures that aim to mitigate mutually unintended effects and enhance benefits. This is the only way to realise promising transformation paths towards a climate-friendly future. It is therefore a question of tailor-made policy packages that are capable of implementing transformation paths that conform with the objectives. For the transformation paths “Multi- and Intermodality” and “Alternative Engines”, a policy package consisting of core and accompanying measures was developed using various methods: literature evaluation, internal ENavi group Delphi workshop, legal-economic modelling, input from living labs and further inclusion of practical experience.

The policy package “Strengthening Multi- and Intermodality” aims to effect a change in mobility behaviour. It consists of two core measures. Core measure I “Promoting public transport” includes increasing the share of public transport in the modal split (among other things, through expansion of public transport networks, and among other things, factors related to clocking, route network, additional lines). Core measure II “Integrated land management” aims at a reduction of motorised individual traffic (MIT) in urban areas through target-oriented land (re)use and urban planning. In order to strengthen the impact of the core measures and at the same time mitigate unintended consequences, these are flanked by further regulatory, promotional and information measures

In order to gain a comprehensive overview of the potential implications of the policy packages, a systematic impact assessment of the (intended and unintended) effects and interactions of the two central policy packages has been carried out from an interdisciplinary perspective. In addition, several stakeholder assessment and feedback loops have been organized. The presentation will lay out the overall approach and detail some specific results.

Ernesto Andrade-Sastoque, Gonzalo Ordonez-Matamoros and Stefan Kuhlmann: **In which (participatory) ways could sociotechnical imaginaries enrich innovation policy instruments for them to be transformative in extractive economies**

Problem: Sociotechnical imaginaries (Jasanoff and Kim 2015) can enrich innovation policy instruments to make post-extractive transitions happen. The emerging framework of Transformative Innovation Policy is pulled by climate change, and to some extent for social justice issues. Arguably, the SDG's 2030 Agenda and policy-making oriented by the energy transition ambition are two of the main drivers for coping such issues. Nevertheless, we consider that following the 2030 Agenda as the main referent of urgent global missions, and focusing the policymaking on energy transitions is not enough for making proper transformation happens in the South.

In countries like Colombia, the economy, the society, and the state are captured by an allure of progress still laying on extractive activities, making them look positive, even sometimes sustainable. This also has an impact on the academic world, and of course, in the field of innovation policy where at most, the pointing of the excessive power that private multinational firms sometimes have territorially, which should be considered for regulations (Giuliani 2018), but never the need to detached the policymaking from funding sources that depends of non-renewable natural extraction: which is denominated in our work as extractive (innovation) policies.

We consider, that the dependency of spurious resources such as ores and oil, have perverse effects on whole the society and the economy, and innovation policy deserves to be more modest recognizing that no governmental intervention for pushing innovation takes this into account, which makes them not-transformative. They respond to specific sociotechnical imaginaries that most of the time are still ambitioning the trickledown effect, economic growth, entrepreneurship, the GDP myth among others, that, in a way reinvent the old Schumpeterian developmentist paradigm originated in the first half of the twentieth century.

There are theoretical ideas, often adopted and transformed as imaginaries, specifically associated with transformative scenarios. A few of them are looking forward to better institutions and systemic relationships between innovation system actors. There are others focused on the transformation of the economic structure. There are scenarios of intergenerational justice, circular economies, ecosystem-based adaption solutions, sociotechnical and socio-ecological transitions, better consumption practices, even about productive transformation and the overcoming of poverty, among others. However, in almost no of those imaginations, specifically in the innovation policy field, the "transformative spirit", is considered seriously why and how, is important for policy learning and policy change the very local sociotechnical imaginaries of social justice, the detachment from natural resources, and decolonialization demands.

This paper tackles the question, in which participatory ways could sociotechnical imaginaries enrich innovation policy instruments for them to be transformative in extractive economies to steer post-extractive transitions, in the southern hemisphere and beyond. Arguably, sociotechnical imaginaries can inform and improve innovation policy-making if they are "used" as a resource for transformative innovation policy.

Methods: In the ongoing research, key governance actors were identified in two regions in Colombia (Magdalena Medio dominated by oil extraction and Bajo Cauca Antioqueño by gold extraction), and were brought together for a two-day Sociotechnical Imaginaries Workshops in each region. Also, a workshop was carried out with scholars working on Transformative Innovation Policy at SPRU in University of Sussex in Brighton (UK). The conceptualization of these workshops and their achievements will be presented. Additionally, numerous in-depth interviews were carried out with policy-makers, officials, scholars and social movement leaders in Colombia.

Regional workshops in Colombia: The workshops allowed relevant governance actors to expand the imagination to inspire more desirable sustainable futures, reflecting on new sectors, technologies, ecosystems, institutional conditions, and innovation policies. The sociotechnical imaginaries popped up, were discussed and used to draft materializable STI projects that could “solve the problem of exhaustibility of non-renewable natural resources” in the long-term, using ores and oil royalties that underlies to an innovation policy instrument in Colombia, the STI Royalties fund.

Workshop at SPRU: The workshop with SPRU scholars working on the conceptualization of Transformative Innovation Policies framework was focused on gaining expert insights to inspire thinking about how to complement a proper heuristic for transformative change in those Colombian regions where we are developing the research. Grounded on the idea to connect “unlinked imaginary objects” to make more sense about transformative change and transformative innovation policies, more than create reflexivity around them (Nelson and Stolterman 2003), the workshop was deployed based on the following questions:

- 1) to what extent transformative elements derived from theory can drive transformative actions;
- 2) to what extent these actions would allow reaching the actual sociotechnical imaginary derived elements in studied extractive regimes which vary according to the already developed workshops in Colombia.

The participants were divided into two groups and took part in a brainstorming dynamic following two basic game rules, 1) silliness is valid; and 2) judgment is not valid.

Initially using post-its, the participants proposed innovative funding schemes; organizational forms, new scientific and state institutions, new means and ways for negotiation, functions, strategies, among other “actions” that the incumbents in the extractive regions could start to pursue the sociotechnical imaginaries they discussed in the Colombian workshops. In the second stage of the workshop, each group picked and choosed only the proposal they felt were fundamental and pasted them in the center of a collective template trying to limit the number of elements up to five. Consequently, participants made sense and connections between transformative elements derived from theory and proposed transformative “actions”, and between such “actions” and the actual sociotechnical imaginaries collected in Colombia. Finally, the participants added quantitative values to the connections they made.

Data and Results: The first stabilized sociotechnical imaginary (Magdalena Medio region) is based on the idea of constructing a society and economy whose core is research and innovation activities in gastronomy, hospitality and tourism where material and immaterial infrastructures for training in multilingualism; chemistry; mechanical, electronic, electric and environmental engineering, should be boosted. The market and governance also must be dominated by small-scale palm-growers-associations, and other oilseed holds.

The second imaginary refers to (Bajo Cauca Region) a social order and economy based in research and innovation activities in ecology, tourism management, rural development, and sustainable livestock and agriculture. Social movements and civil associations play a preponderant role in market and governance. The coordination of research and innovation activities as well as different services, products and technologies take place and are offered by CEDRA (an imaginary Ecotourism Center for Rural, Agriculture and Sustainable Livestock) which is funded mainly with public resources, and is administrated by a collective of public-private parties, included several municipalities of the region.

The result of the third workshop conducted in SPRU described on the one hand, the importance of the relationship between “appropriateness and glocal thinking” as a heuristic building block for

transformative change, and the mandatory need for bringing together social movements and their knowledges to strengthen STI capabilities to support communitarian tourism and sustainable agriculture as the core of the imagined sociotechnical regimen in the Bajo Cauca Region. On the other, when Transformative Innovation Policy researchers thought about how incumbents in Magdalena Medio Region can get their desirable sociotechnical imaginaries, they highlighted the importance, again of “appropriateness and glocal thinking” as a heuristic building block for transformative change but oriented to create a fund fed by oil exploration and exploitation directed and managed by local communities which could imply of circularity of local wealth production for raising sustainable funding.

Discussion: Arguably sociotechnical imaginaries can “travel” (Pfotenhauer and Jasanoff 2017) and be translated as a potential innovation policy design that steers post-extractive transitions (Gudynas 2012). This will be tested in a National Level Policymaking Workshop with the aim to use the insights gained during the case studies and SPRU researcher workshop as inputs to inspiring ways to make transformative an innovation policy instrument that is essentially extractive (The STI-Royalties fund). All the methodology, included the three stages of the research is an experiment profiting from sociotechnical imaginaries that can contribute to understand how to make more participatory Transformative innovation Policy.

A preliminary conclusion, is that there are considerable asymmetries between the imaginations of scholars working on innovation and transformations and local imaginaries of transformation. This will be used as a “device” for running the National Level Policymaking Workshop. We anticipate that asymmetries of imaginations of transformation of policymakers in Colombia are even bigger regarding the ones of the local regional actors and SPRU scholars. This implies that maybe, policymakers are able to talk in transformative terms, but they are not still ready for designing transformative innovation policy instruments that profit from extractive activities.

References

- Giuliani, E. (2018). "Regulating global capitalism amid rampant corporate wrongdoing—Reply to “Three frames for innovation policy”." *Research Policy* 47(9): 1577-1582.
- Gudynas, E. (2012). "Transiciones para salir del viejo desarrollo." Jesús María: Centro Peruano de Estudios Sociales-Red Peruana por una Globalización con Equidad.
- Jasanoff, S. and S.-H. Kim (2015). *Dreamscapes of modernity: Sociotechnical imaginaries and the fabrication of power*, University of Chicago Press.
- Nelson, H. G. and E. Stolterman (2003). *The design way: Intentional change in an unpredictable world: Foundations and fundamentals of design competence*, Educational Technology.
- Pfotenhauer, S. and S. Jasanoff (2017). "Panacea or diagnosis? Imaginaries of innovation and the ‘MIT model’ in three political cultures." *Social studies of science* 47(6): 783-810.

Attila Havas and K. Matthias Weber: **Take or shape: Policy governance modes to address transformation processes**

Background and objectives

Several profound, interwoven societal, economic, and technological changes pose major challenges for decision-makers, as well as citizens. It is a demanding task to make sense of these changes, devise adequate strategic responses, and then identify and implement effective policy mixes.

STI developments play a key role, both as drivers and possible responses to these change processes, operating within a political context that expects from STI novel systemic solutions to major societal challenges. We argue in this paper that a rather ambitious approach is required to address them appropriately; an approach implying to overhaul the current STI policy governance sub-systems with the aim of making them able to (co-)shape the on-going fundamental S&T, economic, and societal changes. That would require a close co-operation with all the major stakeholders, radically renewed policy-setting and implementation processes, in which experimentation and co-ordination between supply- and demand-side policies play a much more accentuated role, as well as devising relevant policy tools. Even a less ambitious approach, that is, being prepared for these changes and reacting to them in an appropriate way, could be still rather demanding.

Our exploratory paper (for oral presentation) is aimed at (i) contributing to sense-making of the on-going fundamental change processes, (ii) exploring two types of STI policy-governance approaches to address these changes; and (iii) considering the relevance of forward-looking activities (FLAs) to assist these STI policy governance approaches.

Structure and approach

First we present a tentative taxonomy of transformation processes, STI governance modes to address these processes, as well as FLAs that can underpin STI strategy setting processes, relying on Havas and Weber (2019). Then we illustrate our argument by considering different types of mobility provision, in which fast disruptive and slow disruptive changes arise. We apply STEEPV analysis to characterise these mobility modes, stressing the role of various actors, their values, interests, objectives, and activities aimed at (co-)shaping these change processes. We conclude by considering the pros and cons of different governance approaches in different contexts for dealing with these disruptions and distilling further policy implications.

Conceptual framework

The on-going fundamental changes at the intersection of STI, societal, and economic processes give rise to different main types of transformation processes: A) fast and disruptive transformations give rise to new, often digital, business models, supersede existing businesses (e.g. Uber, Airbnb, etc.) and lead to entirely new innovation ecosystems, with often unknown consequences e.g. on employment, including labour relations, while giving rise to new, fundamental privacy, safety or ethical dilemmas; and B) slow but equally transformative transitions of existing, often hard-wired, socio-technical systems with strong path-dependences (e.g. in energy supply, mobility). In real life, besides these ideal types, we are likely to observe hybrid forms that are challenging both in terms of their scope and their speed of occurrence (e.g. smart grids).

These different types of transformations cause growing concerns about the direction of change and fears about a loss of control. Yet, they are characterised by different levels of scope, speed, and

uncertainty, and thus necessitate different governance approaches and strategic responses. Thus, we distinguish two main ideal types of STI policy governance approaches, intended either to (a) respond to the disruptive transformations in an effective way, characterised by a strong emphasis on flexibility and responsiveness, or (b) create pro-actively new opportunities for (co-)shaping transitions towards socially, economically, and environmentally desirable directions, thus calling for long-term goal orientation and coherent strategies of a broad range of actors. Clearly, there could be a third approach, namely just “wait and see”, that is, being rather passive. It is even quite likely that this approach will be taken in many countries and regions. Yet, as this does not require thorough strategy-setting processes, we do not consider this case in the paper.

In these ideal type governance approaches we pay particular attention to policy-making processes, and how changes in basic policy approaches come about. This dimension has attracted some attention in some recent work on transitions, but it is still an under-explored aspect in empirical studies of socio-technical change. Whether a responsive governance mode is pursued, reflecting the influence of dominant lobbies, or rather a pro-active mode largely depends on the underlying decision-preparing mechanisms.

Using a simple 2x2 matrix, where we have the types of disruptive changes (fast vs. slow) in the columns and governance approaches in the rows (responsive vs. co-creator) we can identify four cases (Havas and Weber 2019):

- “Wait and react”: adapt to changes minimising negative impacts and adopt new options once available
- “Wait and prepare”: be prepared to exploit new opportunities; avoid taking major risks and creating uncertainty
- “Keep pace”: try to co-shape fast changes, without taking major risks
- “Get ahead” of changes: take the driving seat, take risks, create uncertainty

FLAs can play an important role in preparing political decisions. For both types of transformation processes, FLAs can play an important role in preparing political decisions. In general, FLAs are an appropriate tool for anticipation, joint visioning and soft co-ordination, but depending on the type of FLA implemented – in terms of ambitions and practices – they will be supportive of a more responsive or a more pro-active governance approach, and thus ultimately of the ability to pursue the one or the other type of transformation process. The key dimensions of differentiation are (i) the main aim of an FLA: explore what might evolve vs. give direction to changes with the intention to create new opportunities and new ecosystems for these new opportunities; and (ii) the level of participation: expert-based vs. participatory.

Illustrative cases

Our first example is individual mobility based on private cars. Disruptive technological changes in the early 20th century led to the emergence of a new industry, that is, automotive industry, which offered a revolutionary new mode of personal mobility and logistics. Of the competing technological solutions, the combustion engine became the dominant design. In a few decades, this technological change, coupled with many more technological and non-technological innovations gave birth to a new techno-economic paradigm, “the age of oil and mass production”. (Freeman and Perez 1988) The major actors were businesses, while state actions were mainly responsive ones: the state

provided crucial infrastructure and introduced the necessary regulations, which facilitated the diffusion of this technology, but didn't play any noteworthy role in directing the transformation process. The last 2-3 decades of the 20th century saw incremental technological and major organisational innovations, especially the emergence and diffusion of the lean production paradigm and that of the globalising innovation and production networks (Malerba 2004).

Disruptive technological – and related non-technological – innovations are emerging in the 21st century: autonomous vehicles, electric vehicles, as well as new mobility models. New players are introducing new business models. Closely related innovations and other changes are needed for making these technologies safe, and thus promote their diffusion, including new sensor and software technologies, IoT (Internet of Things), new physical infrastructure (roads with sensors, as well as reliable, stable access to fast internet “everywhere”), and appropriate regulation (at national and supranational levels), new insurance policies. Major ethical issues (liability, privacy, who should be “saved” by the driving software in a dangerous situation, etc.) also need to be solved. For these reasons i) these changes are relatively slow, and ii) the state needs to play a much more active role (NASEM 2018) than in the changes that occurred in the 20th century. Moreover, citizens also need to be involved. In principle both responsive and co-creation governance modes can be applied.

Our second example refers to new types of mobility services, which are disruptive because they undermine the very functioning of our current mobility systems and represent a departure from individual car ownership and single-mode, car-based mobility for moving from A to B. We restrict our analysis to mobility services inside cities, because these can be introduced comparatively fast, due to the possibility to combine them with existing public transport services. These services also question the established business models of the automotive industry, and thus lead to the emergence of completely different innovation and service ecosystems. This does not mean, however, that established players (e.g. major car manufacturers) could not be part of that new ecosystem and transform their business models fundamentally (as currently attempted at a comparatively small scale by several car manufacturers), but there are also new players entering these markets, who may take on strong, possibly even leading, roles in the future. We can observe signals of this emerging development in the engagement of IT companies like Google, and the creation of digital-platform-based service providers like Uber.

The two cases of Finland and Austria serve as examples of responsive (Austria) and co-creation governance (Finland) for dealing with fast and disruptive change in the area of mobility provision. The Finnish example of introducing mobility-as-a-service can be interpreted as an iterative process combining bottom-up initiatives of an entrepreneurial community and top-down framework setting to enable system change. The top-down element required also mutual adjustment of policy initiatives in different domains in order to enable market formation (Kanger and Kivimaa 2018). It thus fits the model of co-creation governance, with using directional FLA. The Austrian case of handling the introduction of Uber and other examples of ride-sharing (such as Compano), on the contrary, must be characterised as responsive (if not restrictive) mode of governance. Entrepreneurial initiative was not complemented by supportive policy action, but rather inhibited by either protecting incumbent stakeholders (i.e. taxi services in cities) or by not adjusting regulations (in particular taxation) that would have reduced uncertainty for ride-sharers (Weber et al. 2014). In this case, there has been no sign of systematically applying FLA methods, but rather of real-time experimentation.

Conclusions

To bring together our simple typologies, for responsive governance modes (that is, Aa and Ba combinations) exploratory FLAs seem to be appropriate, while pro-active co-creation governance approaches (that is, Ab and Bb “pairs”) can be supported by what we call directional FLAs. Further, participatory FLAs would increase the chance of shaping the direction of change by involving the major actors. These processes would align their visions as to which direction to take, and thus reduce uncertainty and orchestrate their efforts and pull together their resources to achieve the desired change, in particular, create new opportunities. Yet, policy-makers and other actors opting for this type of FLA need to be aware of a trade-off between the speed of changes and the time needed for conducting a proper, fully-fledged participatory FLA, that is, a foresight process.

When drawing policy implications, the paper emphasises the importance of taking a multi-layered governance perspective: First, national and regional innovation systems, together with their policy governance sub-systems, provide key framework conditions for addressing transformative changes (fora for major actors to communicate, interact, and co-operate; strategy-setting capabilities; competences in using decision-preparatory tools, especially “futures literacy”; regulations; financial and other support; etc.) to the actors at the level of actual innovation ecosystems, where transformative changes manifest themselves most directly and most forcefully, on the one hand, and where it is the most appropriate to attempt co-shaping the transformative changes to create new opportunities or finding appropriate governance responses, on the other. Second, any given country or region is likely to be fairly diverse in terms of having Aa, Ba, Ab, and Bb “pairs” at the level of innovation ecosystems. National and regional policy-makers need to be aware of this diversity and find effective ways to assist in creating appropriate, and therefore diverse, governance approaches for these different innovation ecosystems.

- Freeman/Perez (1988): Structural crises of adjustment, business cycles and investment behaviour, in: Dosi et al. (eds): Technical Change and Economic Theory, 38–66, Pinter
- Havas/Weber(2019): Responsive and co-creation modes of STI policy governance for coping with disruptive changes, Eu-SPRI 2019 Conference
- Kanger/Kivimaa(2018): The emergence and consolidation of mobility-as-a-service in Finland, SPRU/TIPC
- Malerba (ed.) (2004): Sectoral systems of innovation, Cambridge University Press
- NASEM (2018): Implications of Connected and Automated Driving Systems, National Academy of Sciences
- Weber et al. (2014): ICT-enabled system innovations in public services: Experiences from intelligent transport systems, Telecommunications Policy, 38, 539–557