EARLY DETECTION OF POTENTIAL TOPICS FOR ADVICE-GIVING MECHANISMS IN TECHNOLOGY ASSESSMENT

Niklas Gudowsky, Michael Nentwich, Leo Capari, Walter Peissl

Institute of Technology Assessment, Austrian Academy of Sciences

corresponding: niklas.gudowsky@oeaw.ac.at

Abstract

While many technology assessment (TA) bodies engage in horizon scanning activities, identifying relevant issues and topics in TA usually is demand-orientated (calls, project requests) and individual approaches rather prevail. A more systematic scanning for potential TA topics thus promises to be a valuable add on to the current policy advice giving practices. Horizon scans are abundant in foresight, but often provide policy advice for longer time horizons than current policy making is capable of dealing with. TA on the other hand often investigates issues with shorter time horizons than foresight, i.e. socio-technical developments with the potential of large-scale propagation in the next three to eight years. With the abundance of long-term horizon scans available, a bottom up horizon scanning for topics relevant to TA seems inefficient, especially with the prevailing resource constraints in place that hamper activities such as text mining or trend analysis of basic data such as news alerts or patent databases. Against this background, we want to give an in-depth insight into a recent TA-oriented meta-analysis of existing Horizon Scans stemming from the Institute of Technology Assessment's (ITA) recent approach towards developing a meta-scanning method tailored to the needs of TA and future oriented, yet near term policy making. After identifying sources and defining criteria for TA-relevance, we describe a multi-phased process, which engages technical experts for reducing the initial abundance of identified topics. In a next step TA-researchers perform a multicriteria assessment of socio-technical developments, paying attention to timely relevance and anticipated policy action. After showcasing the process, we will present preliminary results, which have been derived during the development phase.

Keywords: Horizon Scanning; Technology Assessment; Method development

1 Introduction

Some technology assessment (TA) institutions (respectively their boards) conduct regular or continuous topic monitoring activities (see Nentwich 2016, section 3.1). For instance, the British Parliamentary Office of Science and Technology (POST) conducts monitoring on a regular basis, and at the beginning of each legislative period the expected important topics are published in a separate POST Note; this monitoring process also includes proposals from parliamentarians, the scientific community, business and civil society. In TA-SWISS, too, topics are determined on the basis of a continuous monitoring of technological and social developments, with proposals from external experts and the Steering Committee also being included. The Finish Committee for the Future engages in a regular horizon scanning activity, well known as the Radical Technology Inquirer (Linturi et al 2014). More recently the consortium cooperating in running the Office of Technology Assessment at the German Bundestag (TAB) includes a partner (VDI/VDE IT) carrying out open horizon scanning identifying weak signals of

indistinctly emerging scientific-technological trends in order to screen them with regard to their social relevance and possible positive or negative impacts.[1]

Horizon scans are abundant in foresight (Amanatidou et al. 2012). Their results often provide policy advice for longer time horizons than current policy making is capable of dealing with. TA on the other hand often investigates issues with shorter time horizons than provided by horizon scanning activities, i.e. socio-technical developments with the potential of large-scale propagation in the next three to eight years. With the abundance of long-term horizon scans available, a bottom up horizon scanning for topics relevant to TA seems inefficient, especially with the prevailing resource constraints in place that hamper activities such as text mining or trend analysis of basic data such as news alerts or patent databases.

However, while many TA bodies engage in horizon scanning activities, identifying relevant issues and topics in TA usually is demand-orientated (calls, project requests) and rather individualized. A more systematic scanning for potential TA topics thus promises to be a valuable add-on to the current policy advice giving practices. Furthermore such an approach would result in emancipation from the externally driven topic identification.

The Austrian case: for a long time, topic identification at ITA has been a procedure that was mostly triggered by issue-oriented activities of individual researchers or research groups. Monitoring the scientific literature, networking at conferences and exchange with international partners from the TA community and beyond. This was backed-up by rregular internal workshops, which served to discuss future issues against the background of the different disciplinary perspectives and individual professional experiences of ITA staff members. This process was rather implicit and had no dedicated regularity. This changed in 2016 when the ITA team decided to establish a more systematic and pro-active approach. A working group at ITA developed a preliminary process, which was then presented to the whole scientific ITA staff during a first internal workshop. This workshop revealed potentials for improvement with regard to the process and acted furthermore as a quality check for the methodological paths taken so long. After this fruitful discussions and feedback from the group the working group set up: MeTAscan @ ITA. In 2017 the framework contract with the Austrian Parliament for biannually monitoring reports as basis for potential longer TA-Studies commissioned by the Austrian Parliament came into force[2]. This is, amongst others, an example for application of meTAscan @ ITA.

1.1 Aim

Against the above mentioned background, we developed a meta-scanning method to identify upcoming socio-technical topics with a potentially high impact on society, environment, economy, and therefore high relevance for policy making and TA's need of giving policy advice that is future-oriented, yet focusses on the current policy cycle. We will first demonstrate a mechanism for collecting potentially relevant technologies, socio-technical developments, topics and meta-topics on the basis of forecasts, foresight studies, top-ten lists of various bodies. We combine meta-scanning and the exploration of upcoming topics with a potentially high impact on society, environment, economy and, therefore, policy-making. Afterwards, based on diverse criteria, these topics are assessed to identify 'TA relevance'. Among these criteria are uncertainties regarding health or environmental impacts, the prospect of parts of the society being affected unequally, likely conflicts, possible regulatory needs. This interactive process

[1] vdivde-it.de/en/project/horizon-scanning-tab
[2] Monitoring for the Austrian Parliament are jointly conducted with Austrian Institute of Technology, AIT

involves several rounds of group and plenary discussions among TA experts, as well as the use of a semi-automated survey tool with the aim to gradually filter the potentially TA relevant cases, and thus shorter term politically relevant socio-technical developments out of the original set of candidate topics.

2 Methodological approach

In this section, we describe our approach to finding and elaborating criteria for defining the parameters of potential TA topics. Defining criteria has been a learning process for our institution, employing a deliberative multi-dimensional and multi-actor approach with focus on co-creation. A project team of six researchers drafted initial criteria, which were than tested in a workshop with approximately twenty interdisciplinary TA researchers, the large majority of ITA's scientific staff.

2.1 Developing criteria for TA relevance…

Considerate efforts have been undertaken in the field of TA to develop criteria for describing typical TA topics, one of the most recent and elaborate attempts are the dimensions developed during the TAMI-project[3]. Here, Decker et al. (2012) specify several dimensions: problem dimension, political dimension, societal dimension, innovation dimension, and availability of knowledge. Another approach from the field of policy studies developed a definition for emerging technologies (Rotolo et al. 2015), applying criteria such as radical novelty, relatively fast growth, coherence, prominent impact, and uncertainty and ambiguity.

Against this background, we collected and described the following set of potential criteria to be tested in a multi-actor deliberative process, aiming to frame each criterion to the needs of a user confronted with the task of assessing topics in terms of TA-relevance.

- *Radical novelty:* The technology is based on a new knowledge/principle or has been developed in another field and has a fundamentally new application.
- *Availability of networks:* One or more identifiable groups of technology developers, investors and/or stakeholders from one or more application areas are forcing development and implementation.
- *Uncertainty and ambiguity:* High uncertainty about the further development of the technology arises from its complexity, from doubts about its functionality; from unclear application perspectives and interactions with the environment and/or social structures that can hardly be estimated.
- *Ethical implications:* Technology intervenes in (mainly human) life processes, causes social upheavals or can have considerable environmental impacts that could conflict with fundamental values.
- *Public debate/salience:* The technology or one of its possible implications has been/is the subject of considerable media report/public debate over the last five years.
- *Expected political impact:* The technology has possible effects or raises expectations that (national and international) approaches to special promotion, regulation, are mentioned in

[3] TAMI stands for "Technology Assessment in Europe: Between Method and Impact; the project identified best practices for different problem contexts in order to develop guidance for the selection of TA methods and to increase the impact of TA activities. For more details see https://www.itas.kit.edu/english/projects_grun02_tami.php

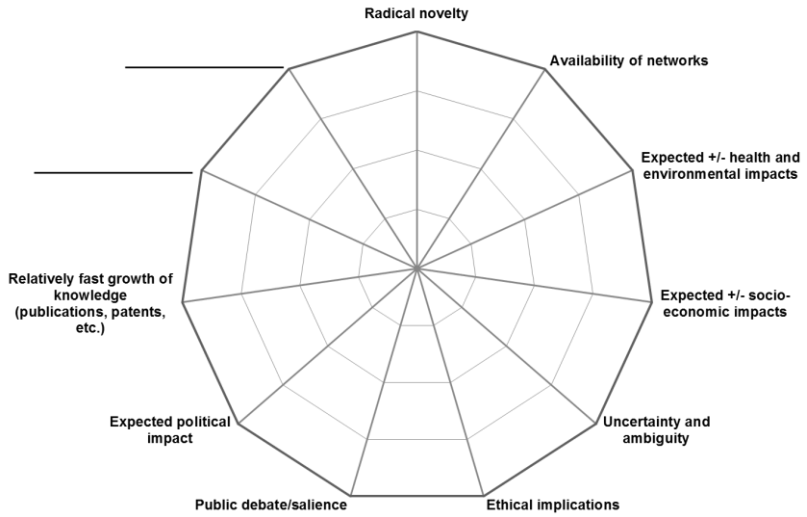
parliament or have plausible consequences for a party, a government member or another political actor.

- *Relatively fast growth of knowledge:* The number of publications (in indexed journals), funded projects, patents, etc. that use the term technology as a keyword is growing faster than the average in the same technical area.
- *Expected +/- health and environmental impacts:* The technology has foreseeable effects that could manifest themselves in plausible risks to human health and the environment or reduce existing risks.
- *Expected +/-socio-economic impacts:* The technology has foreseeable socio-economic effects that can manifest themselves in plausible risks for certain groups of the population or reduce existing risks.

2.2 … testing them in a workshop setting…

With the aim of testing the above-mentioned criteria in an actual deliberative assessment situation, we organised a half-day workshop with ITA's scientific staff as participants[4]. Approximately twenty participants were split into six facilitated working groups and given the task to choose and assess selected exemplary topics (for the type of topics and their selection, see below). Beforehand, in the intitial phase of the workshop, an introductory presentation described the above-mentioned criteria and clarified why these were chosen. After that each working group selected a topic, participants then had a short phase for getting acquainted with the topic and drafting a first individual assessment by quick scoring of the criteria with the aid of multidimensional spider charts (figure 1). Then, individual scores were compared and discussed to find group consent on a final assessment for each criterion. During the individual as well as the group work phase, participants were encouraged to also draft new criteria that were missing, but necessary from their point of view.

Figure 1: Spider chart for multicriteria assessment of socio-technical developments



[4] We extend special thanks to mainstays of this workshop and the early MeTAscan phase, our colleagues Mahshid Sotoudeh and Helge Torgersen.

On the one hand, many participants had no problems applying the above-mentioned criteria in their individual and group assessment, however did not succeed in assessing a large quantity of topics in a half-day workshop. Individual assessment took time and especially group deliberations on such a large set of criteria and relatively new topics were time-intensive. On the other hand, some participants were not able to complete their assessment on the basis of these criteria, critiquing either that such a process would lead to pseudo-quantification of 'gut-feeling', or feeling unable to assess the respective topics based on their limited knowledge and the available information.

2.3 …and reverting to higher aggregation criteria

From the experiences made during the criteria workshop, we concluded that it would be beneficial, in terms of feasibility and expected results to apply criteria on a more aggregated level and oriented along potential impacts and implications. Therefore, we chose to develop guiding questions that explain the scope of health, environmental and safety impacts (EHS) as well as an adaptation of ELSI dimensions: ethical implications, political impact and lingering societal debate, and socio-economic or cultural impacts.

Other criteria that are more difficult to explore in a workshop setting should, if possible, be considered in the descriptions of the respective socio-technical developments (technology cards), i.e. criteria requiring desk research such as 'Relatively fast growth of knowledge', a representation of publication or patent number over time.

These are the guiding questions developed:

- *Possible environmental, health and safety impacts:* Could the technology have an impact on personal and/or public health in terms of physical and mental aspects? Dimensions that could be considered are: ecosystem quality, climate change, resource use; indicators are human toxicity, Ozone layer depletion, biodiversity, etc.
- *Possible ethical implications:* Does the socio-technical development raise ethical questions in terms of privacy, autonomy, self-determination, freedom, human rights in general, gender perspective, diversity. Does it change the understanding of life, work, health etc. (also in terms of perception)?
- *Possible political impact and lingering societal debate:* Does the technology have controversial energy politically speaking ? Are there any groups that might be particularly interested in the topic? Is there potential for political conflict between different groups? Will it become a political issue? Will it require political action? Is it of urgent political interest? Are tensions or conflicts of interest expected between local, national and international politics?
- *Possible socio-economic or cultural impacts:* Does or will the respective socio-technical development have impact on the economic system (production, industry, etc.)? How does this influence society (labour market, cultural aspects, living together, etc.)?

2.4 Developing a process methodology

After defining the above-mentioned criteria for potential TA-relevance, we developed a process, building on previous experiences with expert and stakeholder engagement processes with various methods, such as argumentative Delphi or focus groups.

Process development was organized along predefined aims, assumptions and steps for which we tried to answer the following guiding questions: What is the scope of the meta-scanning exercise, in terms of what sources to include and exclude? What are relevant sources for the scanning phase and how do we assess the relevance of a respective source of technologies /

topics? We decided that while scanning and collecting a list of topics, we aim for being as inclusive as possible, excluding topics in terms of redundancy only. In finding a tool for filtering assessing and prioritising the scanning results, we decided for using both online surveys and face-to-face deliberative methods to ensure efficient use of experts resources on the one hand and, while also reaping the benefits of face-to-face knowledge co-creation on the other hand.

3 Results, discussion and implications

Building on the developed criteria, we aimed for crafting a multi-phased, multi-dimensional process that allows for integrating various expert groups to retrieve specialised knowledge at different phases. We thus aim to integrate relevant information whenever necessary, i.e. knowledge of technical experts during or directly after the initial scoping and scanning, or broad scoped knowledge of TA experts on possible implications of the respective socio-technical development. The next sections will outline the results of our process of designing and crafting a TA-specific meta-scanning and assessment methodology.

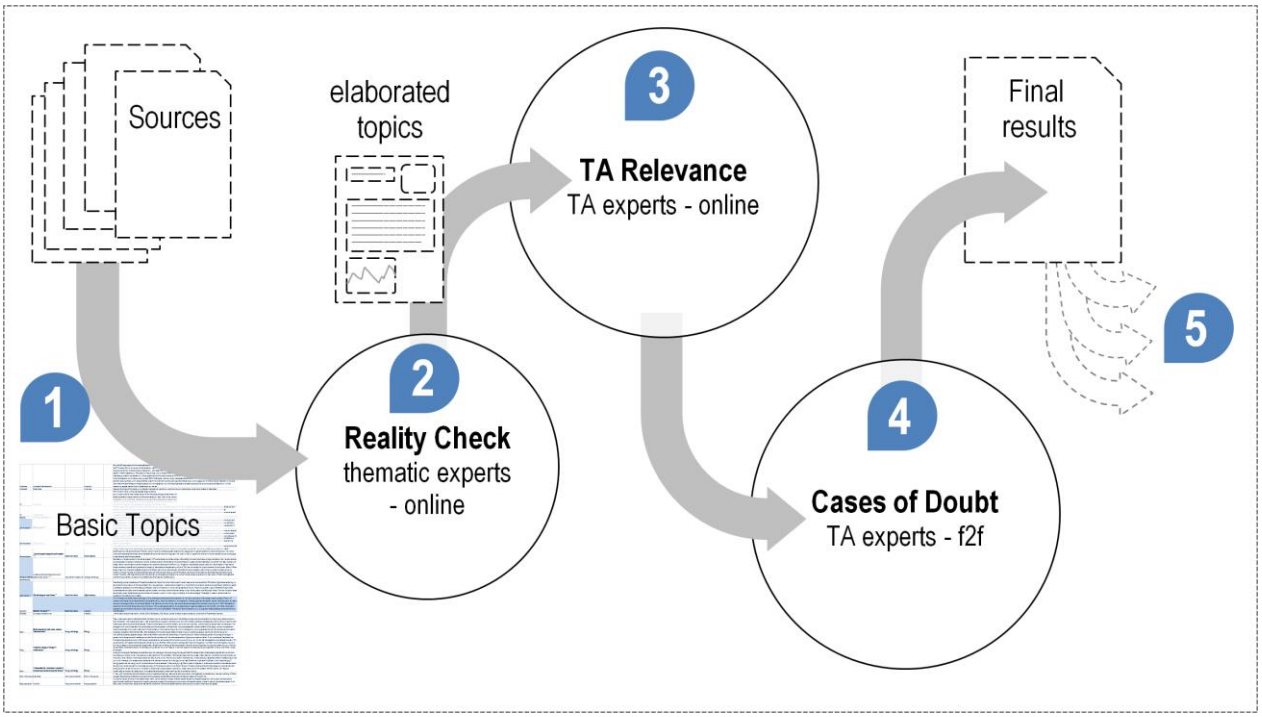
3.1 The meTAscan process

The developed process consists of four obligatory main steps, and an additional fifth step that remains optional. During the first four steps a list of potential topics is build and filtered using different criteria, while the additional fifth step includes several optional modules that can be tailored to specific needs entangled with the aim of the respective process, for instance varying the depth in which the finally resulting socio-technological developments from the previous steps need to be elaborated and researched.

1. Stocktaking in terms of scoping and scanning for relevant sources and topics
2. Reality check as basic filter for ‘realistic’ topics (online)
3. Assessing TA relevance (online)
4. Discussing cases of doubt of TA relevance assessment, reaching a final list
5. Optional additional modules, refining results for different needs

Figure 2 presents an overview of the process, showing the workflow and interdependencies of the different steps from source selection through intermediate to final results. The following sections will describe each step of the process in detail.

Figure 2: Overview and workflow diagram of the meTAscan process



Step 1. Stocktaking: scoping & scanning for sources and topics

During the scoping and scanning phase relevant sources for upcoming socio-technical developments are identified, with special attention given to sources that already aggregate technology trends and future topics, such as horizon scanning activities, foresight reports or top ten lists of emerging technologies[5]. As meTAscan is an ongoing, or at least periodical activity, scoping takes place in terms of not only identifying relevant sources, but also by maintenance of the existing list of sources. Here, continuously searching for new sources and evaluating the existing source list with regard to appropriateness and redundancy is necessary. All topics found within the sources feed a basic list of potential TA topics. After scanning is completed, redundancies are deleted, very small topics (technologies) are merged into relevant socio-technical developments and large meta-topics containing too many aspects are split to manageable size. Also, sorting out those topics that TA institutions have already exhaustively dealt with is necessary as well as clearing out obvious "non-sense“.

Step 2. Reality check – first online assessment with thematic experts

The aim of this step is to engage thematic experts into making a quick first assessment of topics relevant to their area of expertise regarding the time horizon of availability and implementation of the respective socio-technical developments. This module is organized with the aid of a semi-automated online survey tool. The survey is split into several smaller surveys organized by clustering all topics from the list obtained in step one by fields of expertise, e.g. robotics, agriculture etc.. These cluster surveys are then send out to renowned experts previously identified, to make qualified assessments based on their knowledge of the state-of-the-art of the

[5] E.g. OECD Science, Technology and Innovation Outlooks; European Foresight Platform Briefs; Cranfield Futures Database; World Economic Forum’s Global Risks Reports; etc.

respective field. In this survey special attention is given to topics that may potentially become relevant in the next three to ten years, as this time horizon implies that soon-to-be political action may become necessary and therefore anticipatory policy-making could have relevant impact on design, configuration and implementation of the respective socio-technical development. Overall, experts in this step contribute to validating, reducing, and commenting the list of potential topics, filtering out the irrelevant ones, highlighting relevant ones and adding related overlooked topics. During post-processing the survey data, topics identified as non-sense, 'old hats' or with time horizons for expected development that stretches far beyond ten years from now are filtered out, resulting in a confirmed list of "realistic" topics.

Step 3. TA relevance – second online assessment with TA experts

Aiming at assessing if a 'realistic' topic identified in step two may become a topic of potential interest for technology assessment, TA experts are engaged in this step of the process. During preparation, 'realistic' topics are elaborated by desk research and potentially by interviews with selected experts, adding flesh to the description of socio-technical developments that until this point have predominantly been processed with original text excerpts from the initial sources. The resulting online survey portrays elaborated topics, organized within their original clusters. Initially, participants self-assess in which field they think they can make their best qualified assessments. We chose to apply such a self-selection measure, as TA experts are sometimes technical experts in a specific field, yet often very used to working in inter- and transdisciplinary settings across various topics, not seldom stemming from different clusters, thus used to applying a broader perspective and expertise with regard to possible impacts of a respective socio-technical development. After choosing the respective field, the participant is led to assess each topic within this cluster by attributing a metric ranging from zero to two to each of the criteria discussed in section two — EHS and adapted ELSI. The metric sets out to flag out potential TA relevance, whereas the assessment dimensions have the following descriptors: 0 = no assessment possible without TA study; 1 = low expectations that a TA study would deliver substantial results; 2 = high expectations towards 'hot TA-topic'. This way, the resulting list of topics is prioritised with regard to TA relevance on the basis of multiple TA expert assessments.

Step 4: Cases of doubt – face-to-face group discussions

As a preparatory measure for this step, we identify cases where individual assessments in step three differ greatly (split between 1 and 2 or many zeros). Those topics are thus labelled 'cases of doubt'. As expert assessment for these cases differs, a more in-depth assessment is necessary. Here, face-to-face deliberation seems to offer great benefit. Thus, groups of TA experts with heterogeneous backgrounds in terms of fields of expertise are selected to discuss these cases in small facilitated workshop settings aiming to reach consensus on the potential relevance, and additionally start to elaborate possible impacts within the described criteria. Results of these workshops are post-processed to merge all necessary information on the respective topics and produce a final list of TA relevant socio-technical developments.

Step 5: Optional additional modules

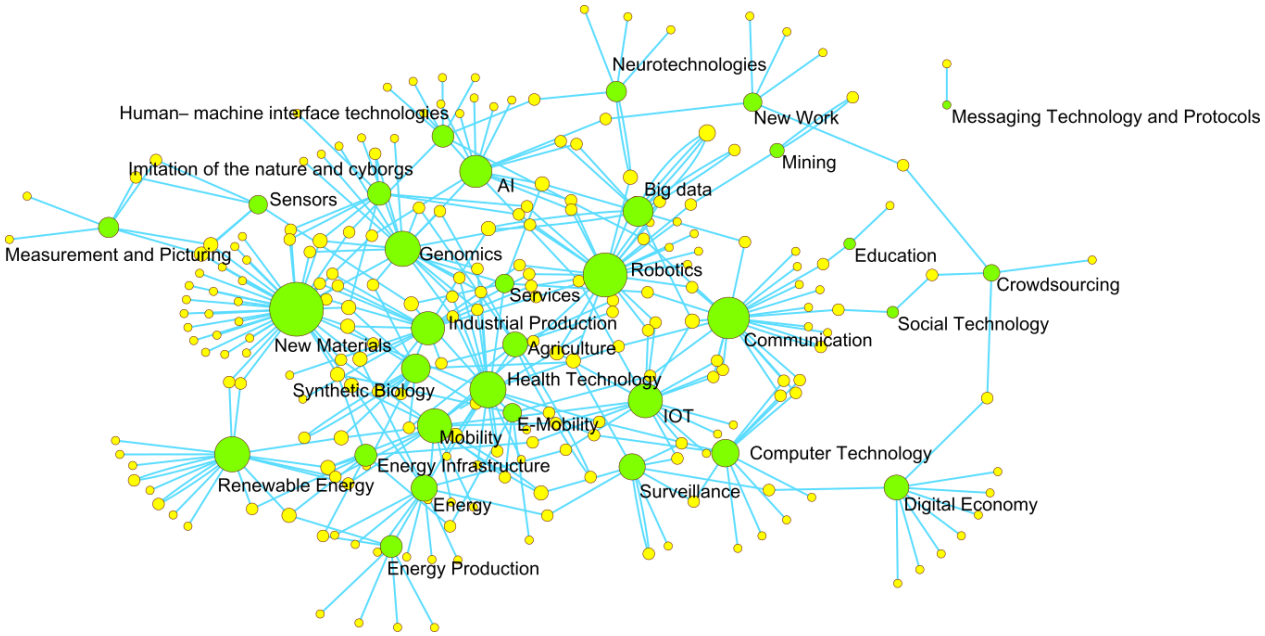
Several additional modules can be optionally connected in series or parallel to further select and specify topics using various criteria specific to the intended aim of the module. For instance, a module (5a) could aim to identify topics with high relevance to a specific institution, e.g. being applied for internal research agenda setting of the Institute of Technology Assessment of the Austrian Academy of Sciences. Here specific criteria such as the institutes research structure and capacity or existing working groups may be applied. Another module (5b) may identify the relevance of topics for the Austrian Parliament, applying criteria specific to parliamentary work in

the national context. Yet another module (5c) may serve to shape academic graduate work, describing topics to be investigated within the scope of master or doctoral theses.

3.2 First intermediary results

Results from stocktaking and scoping phase are illustrated in figure 3 with only the cluster names displayed. Each yellow node represents a topic, while green nodes represent the relational size of the cluster. We found more than 180 unique topics, which were ordered into several clusters, while many topics showed interconnections to several clusters. Here, a challenge was to work with the different hierarchies of the found topics, as some described single technologies while others displayed solid trends or even megatrends. Initially, the project team applied clusters as derived from the original sources, however this was not sufficient and we had to develop a bottom up scheme of cluster and subcluster categories, resulting in a substantial rearrangement of topics.

Figure 3: Network of thematic clusters derived from stocktaking phase

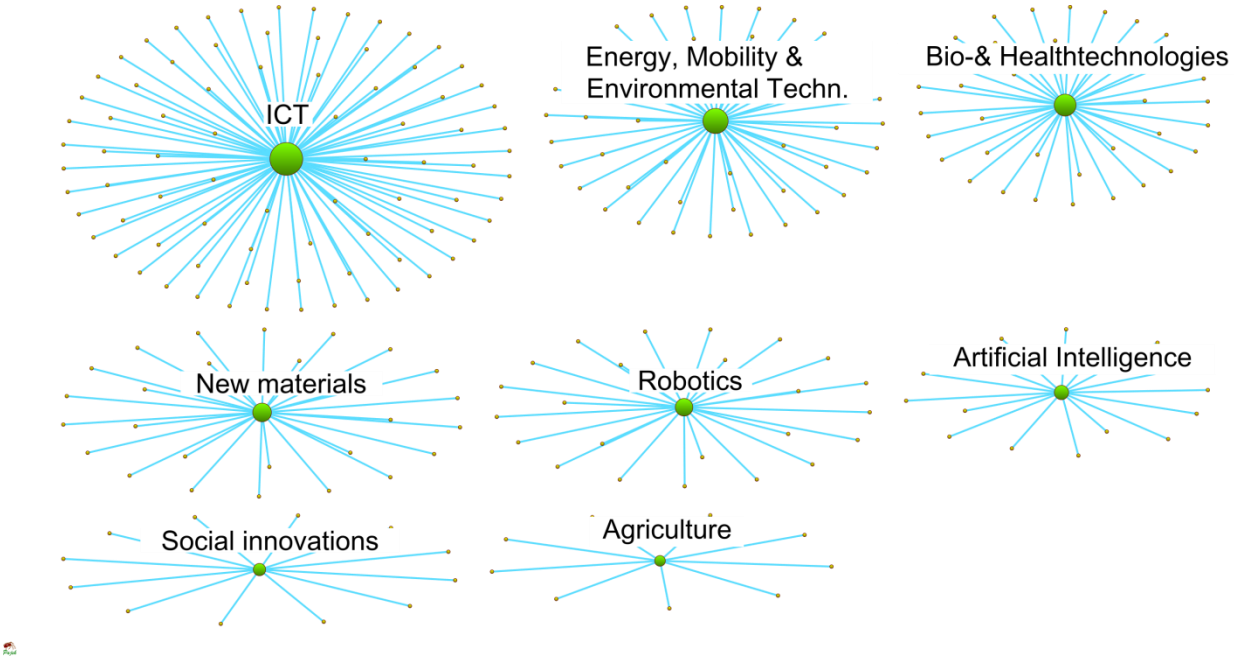


3.3 Adaptive measures for a preliminary assessment

As we prepared the list of topics for assessment by experts, we chose to simlyfy the interconnectedness for pragmatic reasons. While the highly interconnected network of figure 3 had its benefits for exploring the richness of the topics found during stocktaking, a simplified clustering was necessary for conducting a semiautomated survey using an online survey tool. As we aimed for involving experts with specialised knowledge in a certain area to assess whether a topic was realistic and could have profound impact on society, we confined each cluster by

attributing single topics reaching isolated clusters (see figure 4). Since each cluster had to contain a number of topics that would be manageable to for a participant to assess in the online survey in less than half an hour (around ten topics), we attributed subclusters to those cluster with a high number of topics. As a test run we conducted this survey with around twenty TA experts, who had to choose their field of expertise in the beginning of the survey and were then redirected to the respective cluster/subcluster.

Figure 4: Adapted networks for use in online survey



4 Conclusions

From developing and partially conducting the process we can draw some preliminary conclusions based on the lessons learned, while scanning for topics to be selected in preparation of the first two monitoring reports for the Austrian Parliament[6].

We found the process to be useful with regard to producing a large list of potential topics, even if topics differed highly with respect to descriptive depth, quality and position in clustering hierarchy. It produces robust results with high legitimacy due to the involvement of a highly heterogeneous group of specialists (reality check) and TA experts, with rather generalized expertise with regard to assessing potential impacts, all in all offering a broad spectrum of assessments. The anticipated challenge of potential mainstreaming of topics when using third party horizon scans, is weakened due to the amount of sources which were used stemming from different institutional bodies, e.g. scientific literature, NGOs, supranational institutions, such as UN, WTO or OECD. Here, the heterogeneity and abundance of sources offers a high robustness, resulting in an inclusive scanning activity offering a practically holistic snapshot of

[6] For the moment, only the first report is available(in German): https://www.parlament.gv.at/SERV/FTA/

topics with potential relevance for TA and its advice giving mechanisms around at the specific time of stocktaking.

However, it is expected that with an ongoing meTAscanning process available, wher stocktaking is repeated every 6 months, there will be a point of saturation with sources and thus with topics respectively. At this point, a shifting focus to the optional modules described in step five of the process may offer additional benefits for exploring the initially assessed topics further to investigate which kinds of studies may be suitable for this purpose.

However, even if the initial phase seemed promising, development and partial application of the meTAscan process required substantial in house time and resources due to the involvement of the core team in this project, as well as most ITA scientific staff as participants in workshops and surveys as well as discussants after progress presentations. Nevertheless, the method still needs refinement with regard to some crucial steps, for instance the operationalisation of the online survey tool, especially with a larger audience in mind.

With regard to the framework contract and the adhered scanning and selection of relevant topics for the Austrian parliament, time is yet too short to conclude on our initial experiences. However, with implementing meTAscan in preparation and during this contract, we aim for bringing a gap in Horizon scanning methodology perceived from a TA perspective: bringing (long-term) horizon scanning results to the floor of political reality by identifying those topics with potential high relevance for the current policy cycle, to build a more direct approach to policy makers.

As an outlook on future activities, we plan to fine tune some of the steps to conduct a full meTAscan process, engaging with an extended foresight and TA community, as well as other thematic experts.

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