Technology Assessment in Germany

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1 Science and Technology Policy and Technology Assessment

Germany is, with about 82 million inhabitants, the country with the largest population in Europe and covers an area of around 360.000 square kilometres. It has a population density of about 230 people per square kilometre, making it one of the most densely populated countries in Europe[1]. It boarders with nine countries and is located in central-western Europe. It maintains a social welfare system including universal health care and laws on environmental protection as well as universities free of tuition.

After World War II followed a time of rapid reconstruction and development in (West-)Germany. A lasting period of low inflation and industrial growth lead to a advanced social market economy. Germany is the worlds fourth largest economy by nominal GDP (an estimated $3,7 trillion) and ranks fifth according to purchasing power parity ($4,2 trillion)[2]. Despite the social welfare system with redistribution measures, the wealth is distributed relatively unequal (for European standards), which results in a Gini coefficient (scaled from

[1] http://www.germany.travel/en/travel-information/germany-at-a-glance/germany-at-a-glance.html

[2] http://www.imf.org/external/pubs/ft/weo/2017/02/weo-data/weorept.aspx?pr.x=19&pr.y=20&sy=2015&ey=2022&scsm=1&ssd=1&sort=country&ds=.&br=1&c=134&s=NGDPD%2CPPPGDP%2CNGDPDPC%2CPPPPC&grp=0&a=

0 to 100) of 29.5 in 2016 which ranks 13th in the EU (Gini coefficient in the EU 2016 was 30,8)[3].

The German "Grundgesetz" (Constitution) was established in 1949 by the occupying Western Allies with amendments made in 1990 under the reunification of Germany. The Constitution regulates the basic political structure of Germany: a federal parliamentary republic in which the federal legislative power is assigned to the parliament (Bundestag) as well as the representative body of the regional states (Bundesrat). Power is divided between these federal and state levels as well as between the legislative, executive and judiciary. The political structure in Germany is also influenced by the European Union. This is especially relevant regarding legislation, which shows in the form of laws passed by EU institutions. For example, regulations are passed and should be implemented without additional national measures; others, like directives, require national implementation actions. The Federal Republic of Germany is a founding member of the European Union, part of the Eurozone since 1999 and a member of the United Nations, the NATO, the G8, G20 and the OECD.

Article 20 of the Grundgesetz states that Germany is a democratic and social state, in which all state authority is derived from the people. This sovereignty of the people means that any form of state power must be legitimised by its citizens (e.g. by elections). This is extended to the right of any German to resist any person trying to abolish the constitutional order, if there is no other possibility. This outlines the importance of resistance, which is an inheritance of Germany's past dictatorship under the Nazi regime. The Constitution also defines the roles of different government institutions with a strong emphasis on distribution of power and decision making. The Bundestag is elected by German citizens and performs the legislative process as well as providing parliamentary scrutiny regarding the work of the government. Members of the

[3] http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ilc_di12&lang=de (in German)

parliament also decide on the federal budget. This system also gives considerable power to the 16 German states and through the Bundesrat they participate in the legislation process.

The official head of state is the Federal President, yet he or she has mainly a representative role keeping a distance to party politics. All federal laws must be signed by the President. The head of the government is the Federal Chancellor, who is elected by the members of the Bundestag for a four-year term. The German Cabinet is the main executive body of Germany and consists of the chancellor and cabinet ministers. The Bundestag itself is also elected for four years, a party must have at least 5% of votes or at least three directly elected seats in order to be eligible for the parliament. The 19th German Bundestag (from October 2017) has 709 members.

The German economy is the largest in Europe; in 2017, the GDP increased by 0.6%[4] compared to the year before. Foreign trade is of great importance to the German economy, with a trade positive balance of €249 billion in 2016[5], the highest in the world. S&T is closely tied to economic growth and political stability, which is apparent in the continuous rise in funding for public research mainly via the Ministry of Education and Research (BMBF)[6]. In 2013 the budget of the ministry was €13.7 billion, in 2017 it was €17.6 billion[7]. The research and development funds of the German economy were about €62.5 billion in 2015, together with public funding this means about €90 billion for research and development (in 2015) and equates to about 3% of the GDP. This corresponds with European strategies of spending about 3% of the GDP for R&D per year (BMBF 2017: 9).

[4] https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/NationalAccounts/NationalAccounts.html;jsessionid=7090DDAB6540CAA1C0098669A11104A1.InternetLive1

[5] https://www.destatis.de/EN/FactsFigures/NationalEconomyEnvironment/NationalEconomyEnvironment.html

[6] Other Ministries include mainly: Economy and Energy as well as Defense (BMBF 2017: 17)

[7] https://www.bmbf.de/de/der-haushalt-des-bundesministeriums-fuer-bildung-und-forschung-202.html

Germany's national S&T structures are also relevant in the European context; e.g. 30% of all R&D funds from the European Commission go to Germany (BMBF 2017: 9). The national government's main decision-making body for S&T is the BMBF. It funds research across all areas and also professional training and apprenticeships. The Ministry is made up of different departments, which are separated according to thematic areas such as digitalization, European and international cooperation, key technologies, health technologies or sustainability research[8]. The BMBF provides the basic funding for the large research organizations such as the Helmholtz Association, the Max Planck Society and the Fraunhofer Gesellschaft. In the area of research, the BMBF develops strategic lines described in the High-tech Strategy (HTS), which sets the main priorities for several years[9].

This document shows the close ties between societal well-being, innovations, prosperity and competitiveness. As mentioned, in 2017 the federal government spent 17,6 billion Euro on research and development, marking an increase of 9 billion Euro from 2005 to 2017 (BMBF 2017). With this increase also comes a higher need for legitimization. Therefore, the societal challenges Germany is facing are closely connected to and often addressed in, the context of technology. It is not only a question of technological but of socio-technological innovations, which should at the same time guarantee the success of the industry location Germany. Furthermore, finding responses to these challenges is more often seen as a mutual undertaking, in which S&T must be embedded in societal settings. For example, over the last decades demands for citizen or stakeholder engagement have risen and reached the level of decision makers. This implies that decision making structures as well as the funding and conducting organizations in research, science and technology increasingly frame their activities in the context of societal challenges.

Overall, public research, science and technology in Germany can be located within different types of research institutions which include universities, non-

[8] https://www.bmbf.de/en/political-staff-and-organization-1403.html
[9] https://www.hightech-strategie.de/de/The-new-High-Tech-Strategy-390.php

university research institutes, federal as well as state institutions[10]. Four unique national research organizations make up a large part of S&T activities. These are: The Helmholtz Association, which is committed to long-term research goals; The Fraunhofer Gesellschaft, which is mainly focused on applied research for private and public enterprises; The Leibniz Association, which conducts basic and applied research; The Max Planck Society, which is mainly committed to basic research, often in natural and life sciences.

In the context of the assessment of S&T, the BMBF has a division that is dedicated to funding research on the social relevance as well as the chances and risks of technologies and innovation. The Innovation and Technology Analysis (ITA)[11] of the BMBF focuses on innovation and multiple dimensions of future developments, addressing issues such as possible ecological or economic outcomes of S&T, respective societal and ethical debates, or legal questions that may arise. In this way the BMBF funds inter- and transdisciplinary research in the wider field of technology and its societal, ethical or economic perspectives. Further, the projects have direct input in the ministry's decision-making procedures. ITA also supports participatory processes in order to include citizens in the assessment of S&T. The explicit goal here is to make decisions in S&T policy comprehensible for citizens. The projects conducted in the ITA framework can be regarded as technology assessment and a balancing of chances and risks. Overall, ITA as such has a very positive understanding of innovation as a way to solve societal challenges and provide a better future (Grunwald 2018a: 19ff.).

When looking for main advisory structures or bodies related to TA in Germany, several institutions can be named. Perhaps the most relevant one is the Institute for Technology Assessment and Systems Analysis (ITAS) in the Karlsruhe Institute of Technology (KIT), which is one of the largest and longstanding institutions doing TA in Europe. Since 1990 the Office of Tech-

[10] https://www.research-in-germany.org/en/research-landscape/research-organisations.html
[11] https://www.bmbf.de/de/innovations-und-technikanalysen-ita-937.html (in German)

nology Assessment (TAB) at the German Bundestag, which advices parliamentarians in an independent and institutionalised form, is operated by ITAS. Here the advice aims at providing knowledge as a basis for decisions to be made by the Parliament, but can also influence decisions in ministries or other administration. Over the years, Parliamentary TA has become an established practice in the German context, although institutionally still dependent on the will of the Parliament and the parties in it. Overall, TA in Germany has developed in several institutional forms over the years. This ranges from organisations explicitly concerned with assessing the societal, environmental or economic implications of S&T to more 'conservative' ones which have changed from a previous scepticism of TA to its inclusion into their work (Grunwald 2018a: 12).

In the following a list of main institutions concerned with TA is given, ranging from traditionally more technically oriented to focused on social implications and providing advice on S&T in the German context:

- Acatech – the national academy of science and engineering represents the German scientific and technological communities, in Germany and abroad. As a working academy, acatech supports policy-makers and society by providing qualified technical evaluations and forward-looking recommendations. In 2008, acatech joined the national academy, which was jointly funded by the federal government and the federal states. The Convention for Technical Sciences of the Union of German Academies of Sciences (founded in 2002) became acatech[12].
- VDI/VDE Innovation + Technik GmbH was formerly established from the Federal Ministry of Education and Research as a technology center (TZ). The task of the VDI-TZ, which was founded in 1987 as a department within VDI, was to promote technological developments

[12] https://www.acatech.de/uk

in the microelectronics and physical technologies departments. Today VDI/VDE provides guidelines which specifically incorporate values such as safety, health, environment or social quality and aim to guide engineers for developing technologies accordingly[13].

- The EA European Academy of Technology and Innovation Assessment GmbH analyses the relation of knowledge and society given that science, technology and innovation change societies rapidly. The EA informs policymakers and business managers when facing the economic, social and political challenges presented by developments in science, technology and innovation. The Academy was established as a non-profit corporation in 1996 by the Federal German state of Rhineland-Palatinate and the German Aerospace Center (DLR)[14].
- IZT – The Institute for Futures Studies and Technology Assessment was founded in 1981 and examines in its future studies long-term futures, e.g. with assessing scientific-technologic developments, including the impact on society, economy and politics over different time horizons and pointing out new perspectives and options for action[15].
- The Fraunhofer Institute for Systems and Innovation Research ISI analyses the origins and impacts of innovations. They research the short- and long-term developments of innovation processes and the impacts of new technologies and services on society. Founded in 1972 ISI Fraunhofer provides recommendations for action and perspectives for key decisions[16].
- The Netzwerk TA was founded in 2004 and is a network of about 40 institutional and 250 individual members from Germany, Austria and

[13] http://www.vdi.eu/
[14] https://www.ea-aw.org/
[15] https://www.izt.de/en/
[16] https://www.isi.fraunhofer.de/en.html

> Switzerland. It aims to support the cooperation among TA researchers as well as communicate TA to political, scientific, economic and public actors[17].

Next to these, as mentioned, the German Parliament itself has a committee for Education, Research, and Technology Assessment and through this sets the agenda for the Office of Technology Assessment at the German Bundestag (TAB), a main advisory body for the parliament. The topics and issues TAB addresses have to are found in consensus with all parties in the Parliament, not only the leading majority. Using internal as well as external expertise, TAB writes reports which specifically address the parliament in order to support better informed decisions (Grunwald 2018a: 15ff.). TAB is run by ITAS, itself a research centre in the Helmholtz Association. ITAS is one of the largest research institutes for TA worldwide and as such, it focuses on the theory and practice of TA, producing knowledge for policy, decision makers and the public[18]. The institute's wide field of activity ranges covers ethical, ecological, social, political or cultural topics and issues. Main funding comes from the BMBF (basic funding) as well as third-party funding (other ministries or European Commission).

This shows the unique position of TA in Germany: it is institutionalised, both on the level of advising politics and on the level of research. In addition, it seems to slowly but increasingly becoming more established among actors from the field of S&T itself, as the activities of VDI and acatech show. Of course, as past experiences of the Office of Technology Assessment (OTA) at Congress (USA) and its eventual closure have shown (see Chapter 1), TA is always in a state of uncertainty, dependent on political will (especially for Parliamentary TA). In Germany, as in several other European countries much experience in the practice of TA has been gained over the years and networks established (e.g. European Parliamentary Technology Assessment EPTA) providing a fairly stable ground for future work in TA (see also chapter XX on

[17] https://www.openta.net/netzwerk-ta (in German)
[18] http://www.itas.kit.edu/english/index.php

TA in Europe). For Germany and its S&T developments, it is essential to have structures that can respond to growing demands for inclusion, anticipation or expert advice. The role of TA in Germany could ideally be seen as a "balanced mediator" between S&T developments in the context of prosperity and competitiveness and issues of sustainability or engagement. Yet, increasing demand for engagement of citizens or stakeholders as part of the assessment, but also in the decision-making process itself raises issues especially in a representative democracy like Germany.

Within the S&T structure in Germany, TA has a clear role as an advisor to policy and decision makers, especially in form of Parliamentary TA. Here the TAB, which has the explicit role to provide advice for the Parliament, but also other institutions doing TA have political "legitimacy", which is also based on their autonomy regarding the assessment. Yet, as TA is often changing as a response to new challenges or demands, the future of TA activities in Germany may also include different, more experimental forms. This can already be seen in the context of "Real-Labore" (real-time laboratories), which aim to create spaces for transdisciplinary research for transition processes towards sustainability[19]. This blurs the lines between advice, research, addressees and transformation processes and defines new roles for TA. This also shows that TA is dependent on and unique to the political, but also socio-cultural context in which it takes place and has to evolve accordingly.

2 Science and Technology Priorities and Values

The protection of individual liberty and dignity is a main goal in the German Constitution. Its first article states that: "Human dignity shall be inviolable. To

[19] One example for this is the "Urban Transition Lab 131", a project run at ITAS aiming to transition urban development in a specific quarter in Karlsruhe, Germany: https://www.itas.kit.edu/english/projects_paro15_qzrealab.php. Real-time laboratories are also referred to in the overall strategy of the BMBF (BMBF 2014: 45).

respect and protect it shall be the duty of all state authority" (Federal Ministry Justice and Consumer Protection). Issues of human and civil rights make up many articles of the Constitution and cover topics such as the right to freely develop one's personality and the right to life and physical integrity or the freedom of speech and the press. Further, Article 5 guarantees freedom to arts and sciences, research and teaching. In principle Germany's democracy is not just a formal one (guaranteed by the Constitution) but also represents a system of values in which the free democratic basic structure is an inviolable norm. This has developed based on the historical context of the Weimar Republic, in which the even basic rights in the constitution could be changed with two thirds majority, which gave way to the National Socialist Party taking power in 1933.

These values correspond to European ones, such as citizens' rights, equality, justice, freedom, solidarity, which are the main principles of the Charter of Fundamental Rights and the European Union Treaty of Lisbon, as well as sustainability (Schroeder & Rerimassie 2015: 53ff.). Here we can see the embeddedness of Germany and the European Union, also in a formal sense, as the principles of the EU treaty also regulate the national levels. This also applies to S&T policies and strategies.

Regarding S&T priorities and underlying values, the main strategic document for S&T in Germany, the High-Tech-Strategy, is key as it presents the broad vision of research, science, technology and innovation for the next years[20]. The HTS is referred to in the coalition agreement of the government (2014-2017) and is presented as the main document to lead research and innovation, also mentioning the importance of research on the social implications of S&T. The current HTS from 2014 gives the thematic frame in which public funding and stimulation of innovation take place in Germany. It therefore provides a good representation of the strategic priorities in Germany and their

[20] The Ministry provides an English version of the strategy from 2014 here: https://www.hightech-strategie.de/de/The-new-High-Tech-Strategy-390.php. The High-Tech-Strategy as a tool has been implemented for around 10 years.

connection to underlying values. The main challenges and topics the current HTS addresses are: digital economy and society, sustainable economy and energy, the innovative workspace, healthy living, intelligent mobility and civil security (BMBF 2014: 5). These are regarded as holding high innovation potential as well as dealing with global challenges and future well-being. As such, these foci tie the need for research and innovation to the future prosperity and quality of life in Germany. Here, we witness the close connection of the development and (public) funding of S&T and the societal goals of enhancing well-being, prosperity and growth.

A further important part of the HTS, next to the thematic priorities, is the emphasis on the process itself. Here, the underlying values of a democratic, ideally open society can be found. Next to the procedural aspects of providing a creative ground for the flourishing of innovation, the HTS highlights the need for widened ideas of innovation: "We are emphasising an expanded concept of innovation that includes not only technological innovation but also social innovation – and that includes society as a central player" (BMBF 2014: 4). The more conventional focus on enabling better transfer between science, research and industry is expanded, at least in the vision of the HTS, to include various actors of society: "We are promoting innovations and future technologies not for their own sake but for their ability to provide clearly recognizable social benefits. Within our innovation culture, we are integrating processes for identifying and assessing the societal opportunities and risks that are tied to the introduction of new technologies" (BMBF 2014: 10).

Next to core elements of the HTS such as networking and transfer, increasing innovation strength or providing an innovation-friendly framework, issues of transparency, communication and participation are also addressed (BMBF 2014: 13). Here, the inclusion of citizens and stakeholders is seen as a way towards 'better' innovations that are broadly accepted within society. This rests on an understanding of participation for the support of innovation and as a way for the "Federal Government […] to promote development of a participatory, innovation-friendly culture, with the help of new initiatives and

formats. For example, it plans to enable interested citizens to help shape innovation policy and it plans to improve its information provision regarding new technologies" (BMBF 2014: 45).

The move towards more inclusion, although often vague in the question of what useful formats are and how they can be incorporated in the political system, can be seen as a way to increase the legitimacy and acceptance of policies and S&T itself. The basic assumption is that assessing the risks and opportunities of new technologies cannot be left to experts; it requires a wide range of actors. This can be understood as a form of lay morality (Ladikas et al. 2015: 104ff.), in which a public discourse or deliberation on the risks or benefits but also the boundaries of S&T take place. Yet, when looking at the HTS, it is often unclear what role participation should play: this ranges from a way to gain acceptance to being an integral part of transdisciplinary research (e.g. real-time laboratories). This of course is highly relevant for TA, which is often seen as having a main role in facilitating participation.

Apparent in the HTS are the underlying motivations for driving research and S&T development. Well-being, prosperity as well as Germany's dominant position in the light of global competition are referred to throughout the document. These can be related to main values that lead many of the S&T debates in Germany. These include the fundamental rights of individuals and their dignity, as stated in the first paragraph of the German Constitution as well as freedom, citizens' rights, justice, equality, which are fundamental European values (Schroeder & Rerimassie 2015: 53ff.). Main topics of the HTS, like well-being, health or security, as mentioned above, can be directly connected to basic values, rights and freedoms. They form the prerequisite for the framing of priorities and challenges (e.g. individual freedom and dignity is the requirement for focusing on well-being, security or healthy living).

Also important in this context is sustainable management, which is considered one of the priority tasks of the future. The HTS describes the way we produce and consume should be more resource-efficient, environmentally

friendly, socially acceptable and thus more sustainable. Research delivers insights how human activity affects the climate and complex ecosystems. Over the past decades the German political landscape has been highly influenced by sustainability or sustainable development, which has also shaped debates in the context of S&T[21]. This is often connected to the idea of responsibility (e.g. for future generations) and as such also determines the priorities of S&T. For example, the energy transition or the highly contested discussions on nuclear waste disposal are often debated the context of sustainability. This can be seen as a specific characteristic of Germany, as the value of sustainability has become important in regards to the wider understanding of responsibility (in S&T) (Ladikas et al. 2017) as well as created concrete measures, instruments and tools (e.g. for industry standards). Also, it has brought to life numerous local or regional initiatives that aim to re-shape how development or progress are understood[22].

This all frames the way in which S&T developments are debated and governed. Generally, in Germany (as well as Europe), the discourse on possible risks of S&T is predominant over that of innovation, which relates to the importance individual's rights and their protection and safety. This is different to other countries such as China or India, in which the discourse on innovation is stronger (Stemerding et al. 2015: 109). Debates and discourses on S&T developments and implications for individuals and society can take place in more professionalised ways, but also in form of dialogue formats or public controversies. Discourses of reflexive ethics often take place in established

[21] An example is a Helmholtz coordinated project from 2003, which developed an integrative sustainability concept focused on providing rules and reference points, flexible enough but also robust, for actual use in practice (e.g. in areas such as mobility, living and building, food and agriculture. (for publications see: https://www.itas.kit.edu/english/gze.php) A more current project is one on sustainability management for non-university research centres (LeNa) from 2016, which developed a framework for Helmholtz, Fraunhofer and the Leibniz Association. (see: https://www.itas.kit.edu/english/2016_055.php)

[22] One example of this is the ITAS project "Quartier Zukunft", which is a local urban initiative to make a city quarter more sustainable in a wider sense. This includes transdisciplinary activities regarding consumption patterns, or economic and social aspects. http://www.quartierzukunft.de/en/

committees, such as the German Ethics Committee. Lay morality (debates by actors with no specific scientific expertise, but with a claim to be heard) forms another important space for debates on S&T. In Germany, as seen in documents like the HTS, this area is increasingly gaining importance for policy. By stressing the significance of participation and the inclusion of citizens and stakeholder within the decision-making process, there is a certain overlap between the procedural level of institutionalised ethics and the ethical debates of lay people. Of course, the actual inclusion of outcomes of participation remains challenging for Germany, as it is in many other countries. These newer formats present a kind of "disruption" to the established representative democratic system. The underlying value of the individual's rights, also to be heard, regarding decisions on S&T, often forms the basis for demands of participation. This shows that, as in any society, values or normative framings are not set in stone and do not directly result in action (or non-action). Instead they are socially debated and conflicts can occur. Especially in the context of lay morality, debates and disagreements between different groups are an essential part of how priorities are negotiated and then defined or changed.

Political decisions in Germany are often characterised by a balancing of values. They can revolve around the protection of individual rights and the welfare of the general public. The different poles are particularly evident when it comes to ethical issues, e.g. when introducing a new technology. Furthermore, the balancing of these different values can also be seen as a value in itself. As described above, this is an essential part of the value system in Germany and frames many of the debates on S&T.

This can also be traced in one of the main areas in the HTS. Civil security, which includes topics like security research, cyber and IT security and secure identities, has become important because societal and technological developments, such as the wide-spread use of the Internet or increased global networking, have raised issues for the public as well as for policy. The protection of privacy and individual freedom have become key issues for the government in the light of ever evolving technological advances. In Germany, we can see

the link between the S&T priority of civil security and the research or development needed for this and the basic values of rights and freedom for citizens. The HTS makes this clear: "The Federal Government's aims in this area include helping to safeguard individual freedom. Solutions in this area also help enhance citizens' security and quality of life – and they help to strengthen the civil security sector" (BMBF 2014: 28). Efforts can further be tied to the value of equality since another objective is to protect privacy and freedom in the Internet in order to also ensure opportunities for all persons to participate (BMBF 2014: 28). This also shows how values are used for argumentation (and legitimization) of funding certain S&T areas. Furthermore, we see the importance of societal use or application of research and technologies in funding and policies. Naturally, this is an ongoing issue that depends on negotiations and debates among a variety of actors.

Another example of S&T debates that shows the underlying values in Germany is the development of service-robots, especially in the area of care. An ageing society and demographic change in Germany are dominant societal challenges, which bring about debates on possible technical solutions. This means that S&T priorities are, for instance, focused on developing robotic systems and including them in the daily lives of people in need of care. Expectantly, this area raises very sensitive issues such as privacy, access or dignity, also in connection to individual rights. A recent project on humanoid robots funded by the Ministry of Education and Research also focused on the area of health and care, mainly on the aspect whether robots were more accepted if they resembled humans or not [23]. If robots were described as a technical tool they were more likely to be accepted than if they were assigned more human attributes such as the ability to act independently. So, even in the area of care, where qualities such as warmth and helpfulness are important, robots should not be humanised too much. This example uncovers how values of individual freedom or dignity, which are ascribed to humans, can also determine the

[23] Description on the project: https://www.bmbf.de/de/humanoide-roboter-sympathisch-oder-unheimlich-4918.html (in German)

design of technical systems such as robots, which in turn is highly relevant for S&T priorities.

3 TA state-of-art – Methodologies and Impact

In Germany, there is a tradition of TA as policy advice, which, for instance, also shows in the form of Parliamentary TA. As described above, the TAB has the specific mandate (appointed every 5 years) by the parliament to conduct assessments on agreed topics. It conducts studies and writes reports by collecting expert assessment from different fields of relevance for the specific technology or issue. The clear addressee of these reports determines the type of TA that is done at TAB: it focuses on the requirements for the legislative and aims to "make a difference" in debates and decision making. Some examples can be named, where TAB reports created discussions beyond the Committee for Education, Research and Technology Assessment. For example, the early study on Nanotechnology, which lead to a funding program on Nanotoxicology as well as a study on a nation-wide electric blackout, which sparked changes in ministries and municipalities (Grunwald 2018a). In this form of TA as parliamentary advice, the actors involved are mainly the TA experts, experts from other relevant areas such as law, ethics or science and the members of parliament. Yet, as the blackout report showed other actors can also become important: such as ministries or local administration. Overall, it is difficult to clearly trace the effects of TA studies in decision and policy making, even with a specific addressee (Hennen et al. 2004).

A further level of TA as policy advice in Germany are the projects done for German ministries, research organizations or the European Commission. These range from numerous S&T topics, with different foci: social implications, potential risks and benefits for stakeholders or environmental aspects, often addressing diverse target groups (e.g. public, policy makers, industry).

Main actors involved are TA researchers, researchers from other relevant disciplines, policy makers, but can also include representatives of civil society or industry as a way to gain further insights on important aspects. An interesting example of a recently completed large-scale project in the area of TA as policy advice is the Helmholtz-Alliance "ENERGY-TRANS", which aimed to give an interdisciplinary perspective to predominantly technical oriented energy research in the German context[24]. This project, with work of around 100 researchers in 17 sub-projects, was initiated during a very specific political climate in Germany: after the nuclear power accident in Fukushima, Japan in 2011 the German government decided on the "energy transition", i.e. abandon nuclear energy and replace it with sustainable energy resources. From a TA perspective such a rapid policy change means that not only the technical transitions are enormous, but also the social ones requiring knowledge on the affected systems as well as knowledge for orientation and action (Grunwald et al. 2016). This was the focus of the ENERGY-TRANS project dealing with consumer behaviour, acceptance issues or participation in planning processes; in general, research on the transformation of socio-technical systems and establishment of new infrastructures to meet this challenge. Policy briefs published during the project showed possible areas for policy action, but also for industry or research. ENERGY-TRANS was a project with a goal of providing knowledge in light of fairly fast and substantial changes of the energy system. The interdisciplinary approach, which became a collective orientation along a common framework in the course of the project (Grunwald et al. 2016), shows additional elements of a TA as policy advice.

When looking at TA as public debate, it is important to understand engagement as an essential part of TA's conceptualisation (Hennen 2012: 30). In this sense, the inclusion of citizens or stakeholders in order to add to the assessment itself, is key in order to better understand values and perceptions. Here, two approaches can be identified, although they may overlap in practice. One is to engage citizens or stakeholders as an element of the assessment itself,

[24] http://www.energy-trans.de/english/index.php

to better understand the ethical, cultural or social issues and arguments. In this case, the goal is to improve the knowledge basis and in the longer run to come to more robust (policy) decisions. As such, this could be an element of a parliamentary TA study. The second, is to initiate engagement of these actors as part of the decision-making process itself, for example to help set S&T research agendas. In Germany, we find many examples of participatory elements in TA studies, ranging from topics like Nanotechnology, Big Data or in-vitro meat. In this second approach, different methods (e.g. focus groups, citizens' conferences) are used to increase the knowledge basis and to add to the assessment. Moreover, these activities can open debates and raise awareness, especially on new and emerging technologies (Grunwald 2018a).

The participation of citizens as part of the decision-making process itself is rare and difficult to realize in practice. This has to do with the political system in Germany, as mentioned above. From this perspective, the system has legitimate decision makers in place, elected or appointed, which therefore are able to make decisions. Often participation aims to create suggestions for policy action, for example, citizens provide their priorities for future funding of research. One prominent example of this is the Citizens' Dialogues on Future Technologies initiated by the BMBF from 2011 to 2013. These were large-scale participation events across Germany on the topics of Energy, High-tech Medicine and Demographic Change. The outcomes were citizens' reports with suggestions for priorities and actions. Interestingly ,the Ministry engaged in a dialogue with the citizens and allowed for a re-framing of the topics during the process. Although the reports were given to the Ministry and some effects in funding priorities can be traced, the large effect on policy decisions by the Ministry is still missing (Hahn et al. 2014). Overall, even though there is political commitment and several examples can be named of engagement initiated by the political arena, some aspects remain unclear. Although the interest is high and approaches such as Citizen Science are gaining attention (and funding), it remains difficult to actually integrate participation in decision making. This is a main challenge for TA.

Another aspect of TA in public debate that can be mentioned here, in the context of sustainability, is engagement in transformation processes that has gained increasing attention in Germany. Here, engagement is understood as co-design and co-creation of knowledge in transdisciplinary processes (Mauser et al. 2013). An example of this are real-time laboratories, as described above, which offer spaces for transition processes to unfold. TA's role in this context changes from the more distant advisor in parliamentary TA to one which accompanies processes of change. This of course needs to be reflected as it brings up issues of distance and embeddedness for TA actors within the transformation process. TA in this context may move from a more distant observer and assesser to an embedded actor who co-shapes processes.

TA in engineering processes is perhaps the most challenging perspective in TA as it requires an integrated approach of the assessment. For example, constructive TA aims to accompany the development of technologies throughout the process. The idea behind this approach is to design engineering processes more reflexive and to integrate values, interests and possible outcomes of technologies better. This kind of TA is not as common in Germany as the previous ones, yet examples show specific approaches of integrating TA in development. In the area of technologies for health and well-being, bringing together TA researchers with engineers and developers is being used as a way to adapt technologies to specific demands and requirements of the users. The TERRAIN project[25] for example, is developing man-machine interfaces which produce acoustic and haptic signals to support daily mobility and overall more autonomy. The approach in this project shows that TA is done in close relation with the development during the entire process, focusing on technical, legal, economic and especially ethical and social aspects. By accompanying the user studies and participating citizens, the TA approach evaluates findings and brings them back into the development process. In this sense, TA researchers

[25] http://www.itas.kit.edu/english/projects_wein16_terrain.php

not only mediate between human and machine, but also between affected people, citizens, experts, and the developers.

Another example of this approach is the project QuartrBack[26] which aims to enable people with dementia to safely and autonomously access their neighbourhood spaces. The technology developed for this purpose should be demand-oriented by locating and monitoring patients as well as connecting to possible existing care systems. The aim is to combine an "intelligent emergency chain" with a network of relatives, care workers and volunteers, who can respond in emergencies. Here again, TA is integrated in the development process by investigating expectations and demands of different stakeholders as well as accompanying a wide field test which will apply the technologies and existing systems under real-life conditions.

As these projects show, TA as part of the engineering and development process is an essential aspect of assessing technologies, especially if these are to be applied in sensitive areas, such as health. This approach means a specific role for TA, which is to mediate between potentially very different stakeholders and find inter- and even transdisciplinary ways to do this. It also means that TA needs to continuously reflect on its role, especially when close to the development process. In order for the assessments to be regarded as credible (also by the various stakeholders), TA researchers have to balance distance (important for the inclusion of different perspectives and awareness of the wider context) and closeness (needed for working with developers) in order to not be seen as merely promoting a certain innovation (Grunwald 2018a: 45). As both projects described above are funded by the Ministry of Education and Research this shows a certain political will to enable this kind of research and advice in the German context.

As the descriptions above show, TA is generally well-established on a research and institutional level in Germany. Currently, the main roles of TA revolve in the area of raising knowledge through scientific assessments, social mapping

[26] http://www.itas.kit.edu/english/projects_wein15_quartrback.php

and policy analysis. This covers the “basic” spectrum of assessment as it includes the scientific, societal and policy aspects; all important for a comprehensive understanding of S&T developments within a given societal context. Furthermore, TA can easily be included in a representative democratic system as in Germany, since it remains largely independent from the decision makers. In this sense, raising knowledge is part of the core business of TA in Germany, also because it is a way to map existing conflicts and debates next to technical options and policies.

Moreover, the level of raising knowledge is grounded in a ‘traditional’, scientific oriented understanding of TA: to provide advice as an independent actor by assessing all relevant aspects. Also in the area of raising knowledge, TA can focus on its own assessment. Here, other stakeholders or actors do not necessarily have to be involved, other than as a way to gain knowledge on a specific question or issue. This role of TA in the German system is especially prominent in the work of the TAB, in its reports for the German Parliament. These are written by TA experts by including the input of various experts from diverse areas, depending on the S&T question. These reports comprise scientific and social aspects and can include policy options. In this case, the frame and the order of the report is clear: provide a comprehensive overview of the issues as well as potentials and risks of a specific technology as a basis for decision making.

In the area forming attitudes and opinions, TA in Germany is mainly concerned with agenda setting, especially stimulating public debate and mediation, although this is more complex as it requires the inclusion of stakeholders or other actors in an active form. In the German context, there is also a strong and active civil society, meaning that interested public, stakeholders, etc. are represented by various groups who can organize themselves effectively. Many issues can be and are addressed by different actors, who are all involved in discussion on S&T. If issues haven’t already been addressed by the civil society, TA can bring these on the policy agenda.

In addition, TA in its function of stimulating public debate can actually function as an impartial mediator for facilitating discussions, based on its finding from raising knowledge (technical options, social mapping and policies). This role of mediation is especially significant in the German debate on sites for nuclear waste, a long and controversial topic with many diverging expert opinions and political gridlocks. Here, projects such as ENTRIA[27] aim to conduct interdisciplinary and independent research, e.g. from possible sites for nuclear waste, whilst addressing the public as well as research. TA's role here is to "build bridges" by conducting assessments and based on those coming to processes for eventual decision making that are agreed upon by a large number of the actors involved and are therefore legitimated. This also reaches into the area of perceived democratic legitimization, in which at least different opinions are accordingly acknowledged leading the recognition of the process by all actors involved.

Regarding the area of initialising actions, it is difficult to find direct and causal connections between TA and specific policy initiatives in the German context. On some impact levels TA has a clear role (raising knowledge and forming attitudes), unlike in the area of initialising actions, which remains difficult. In Germany, TA often resides in the (legitimised) role of the advisor, independent from decision makers. Enabling actions on the level of policy is difficult for TA, also because certain decision-making processes are established. Therefore, an impact of TA towards initialising actions is still difficult to observe.

In the reframing of a debate, TA can offer clarity and possibly new orientation regarding potential benefits or risks concerning S&T developments, which can then be the basis for policy decisions. However, introducing new ways of governance or even passing new legislation as actions initialised by TA remains highly difficult in the German context but assumingly also in other countries. One example of the introduction of a new process of governance can be seen in the commission for finding a long-term disposal site for nuclear waste. As

[27] http://www.itas.kit.edu/english/projects_hock13_entria.php

mentioned above, this has been a highly debated issue in Germany for decades involving many interest groups and positions. Unique about this commission, which was initiated by the German Parliament (in 2014), was its structure: it was located at the Parliament, its members were appointed by the Parliament and the Federal Council. Yet it was not a committee or part of the party fractions. Instead it was made up of representatives of civil society, science and national and federal politics and as such prepared legislation, mobilised expert knowledge, engaged citizens and mediated between national and federal interests. Therefore, the commission itself was not tasked with finding a final disposal site, instead it developed criteria and recommendations for the search of a site, so coming to a legitimate, transparent process. TA aspects were embedded in the commission's work, as it dealt with societal aspects, but also how to engage citizens or stakeholders as part of the search process. As a whole, the commission was able to introduce at least a first step towards a new process of governance in a highly disputed area[28].

3.1 Future Challenges of TA in Germany

From this brief characterisation of TA's various roles in Germany, we can also identify certain challenges and future needs. As a fairly well-established and institutionalised undertaking, TA in Germany has specific set roles in decision making processes. As the TAB case shows, there is political will and legitimization for TA processes as a basis for decision and policy making. Yet, this established TA also remains tied to the political system and is dependent on its goodwill. As the more traditional forms of TA show, this can "limit" the assessment to expert reports and a single addressee (members of Parliament). Yet, in an increasingly globally connected and networked world with grand challenges such as climate change, the addressee of the national state can limit the spaces of action. For TA it is therefore also important, next to the

[28] https://www.bundestag.de/endlager-archiv/

national level, to address the global level. As an experienced TA country, Germany can offer a rich and knowledgeable basis for this, but needs to be open towards new ways of doing TA in diverse contexts. This also challenges notions predominant in Germany or Europe, that TA is directly tied to democratic and pluralistic regimes (Grunwald 2018b). Of course, basic aspects of TA such as engagement and the inclusion of (lay) ethics are directly linked to a democratic understanding of how policies should be developed. Yet, moving towards a global level of TA also means reflecting and even including other value systems. This also means that certain roles of TA as described above may not be desirable in other contexts and different levels of engagement might be more appropriate in different value/political systems.

A future challenge for German TA can be regarded as finding conceptual and practical ways to encounter TA in different settings and value systems. Yet, building on its wide experiences, German TA can help set the scene for a global TA community as well as foster reflection on other settings and expectations and demands. In this sense, it could help create a (global) habitat for TA (Hennen & Nierling 2015: 54ff.). Mutual understanding is the prerequisite for learning from each other. Already the German context shows that TA, if it does not want to stagnate, has to react sensitively to changed social conditions and new socio-technical challenges. This shows in the increasing importance of engagement methods in TA processes to the implementation and research of trans-disciplinary projects. The processual nature of TA, a constant questioning and reflection, is a basic requirement for establishing TA in other national contexts and then comparing them.

The contexts in which TA can be institutionalised differ. The German case shows that impulses for the establishment of a TA vary, depending on whether they are scientifically motivated or in the form of consulting needs that are politically and socially desirable. For example, the curricula of some German universities e.g. have in recent years changed to include conse-

quences and implications of S&T developments, mainly as an academic endeavor[29]. Further, politics (in the German case the Parliament) can be a strong driver for TA. Increasingly policy decisions have to be made in the face of unsure knowledge as well as diverse implications for society. Here, an institutionalised TA can offer legitimate and independent assessments as well as policy options. Further, these options can be elaborated and confirmed in processes of debate between advisors and advisees.

4 German Perspectives for a Global TA

From a national perspective, the established form of TA in Germany is well-fit for the specific political system. It provides advice on numerous S&T developments with societal issues, often has a clear addressee (national parliament) and incorporates different kinds of knowledge (e.g. expert or lay perspectives). As a country with a representative democracy, Germany requires this form of TA, which may include insights or recommendations from citizens, but leaves the decision making up to political representatives. As described above, this is partly shifting towards more co-creation forms with real-world laboratories and transformative research. This goes along with wider demands for more engagement in the policy setting, also in terms of S&T. In this way, the national characteristics of TA are changing and becoming, at least to a certain degree, more inclusive. A basic non-negotiable value of this is the right of the individual also in connection with democracy. Therefore, mediation such as bridge building or blockade running is a basic characteristic of TA in Germany. Activities surrounding building trust, creating platforms or providing neutral ground for dialogues are key to this role of TA, which is part of a democratic society accustomed to forms of public debate, with a lively

[29] One example is the Munich Center for Technology in Society, which offers study programs in S&T studies or Techno Science Studies (https://www.mcts.tum.de/en/startseite/)

civil society as well as individual citizens. This aspect is non-negotiable as it forms the value-basis of the political culture in Germany.

As the description above shows, Germany has an established and experienced TA, which includes research, networking and advice and which can serve as orientation for a global TA approach. Raising knowledge and forming attitudes as a means to make more robust decisions in accordance with society's needs and responsive to specific stakeholders, is a key role for German TA in the global arena. This of course does not come without difficulties, which may also result in disagreements on appropriate methodology, e.g. forms of engagement. Therefore, when thinking about a global TA form, it is important to take into account the national specificities regarding certain technological developments as well as the more general framing of the issues.

As we have seen, S&T priorities are based on certain values. This is also the case for TA. Therefore, TA may vary not only due to different political, but also due to value systems. In this way, a global approach would also include the consistent negotiation of specific TA approaches in each country and how this can be scaled up to a global level. Furthermore, it would also mean a continuous self-reflection of TA and its methods. This should include mutual learning and the adoption of best practices, as applied in other countries for specific needs, in the German context. A widening of options through the global context would enhance the self-reflection capabilities of national TA. This can form the basis of an evolving of German TA, which can take up methodological and reflexive adjustments to an ever-changing national and international context.

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