Julia Hahn & Miltos Ladikas

Constructing a Global Technology Assessment

Insights from Australia, China, Europe, Germany, India and Russia

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Content

The Case for a Global Technology Assessment

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The term Technology Assessment (TA) is a Western invention, but its purpose and methodologies are far from a Western exclusivity. The appeal of TA is universal since it is interlinked and indeed, it even depends on scientific and technological developments. One could argue that, where there is technology, there is necessarily TA. But the 'whens' and 'hows' in this relationship vary greatly from country to country and situation to situation. It is not a matter of whether TA is undertaken when science and technology develops and its results are applied in real life. The answer to such questions is always in the positive. Even if not termed as such, TA is evident one way or another since any kind of application is necessarily the result of an assessment. What matters is the timing of the TA, e.g. when is it done in the S&T development trajectory and predominantly, how it is done. There is tremendous variety in answering the 'when' and 'how' of TA and one is instinctively prone to view culture, values and politics realities as the main parameters in the answers. But, is this actually the case? Is TA evident in other parts of the world in a similar style with our Western approach to it? Whether yes or no, what are the actual parameters that impact its application? Is culture a significant dynamic in TA or are there other more important preconditions for its development? And, while looking at differences between regional developments around the globe, are we able to find any significant commonalities? Is a common, global TA possible at all?

This book represents a first attempt to provide answers to such questions. We say 'first' because we are not aware of a similar initiative elsewhere and 'attempt' because we are not trying to provide definitive answers. We are far from global solutions in every urgent matter that humanity is faced with, let alone TA. But as with every other aspect of common importance, S&T developments are borderless and so should TA be. As such, we are starting here the inquiry into how TA is done in various regions with examples from key countries around the globe.

The history of TA is well rehearsed but for the sake of the readers that are not so familiar with it, a short summary is provided here. Although TA activities have been part of S&T for a longer period, official TA (i.e. the activity termed as such) was established in the 1960s, focusing on concrete predictions of technological consequences. The main aim of this first TA was to gain advanced knowledge on technology options in order to create better informed policy decisions (Grunwald 2010). This was an 'early warning' system that was central to the identity of TA as it was seen as the means to identify potential hazards and minimize their effects. The first official TA agency in the world was appropriately named Office of Technology Assessment (OTA), and was specifically established in 1972 to provide scientific advice to the US Congress. The reasoning behind OTA was to contribute to the political decision-making process by delivering comprehensive knowledge on S&T consequences. In the words of its makers: "it is essential that, to the fullest extent possible, the consequences of technological applications be anticipated, understood, and considered in determination of public policy on existing and emerging problems" (United States Senate 1972).

OTA represented what came to be known as 'classical TA'. This is the type of TA whose functions are still valid within the TA discipline and which include the identification of impacts of technology, assertion of cause-and-effect relationships and the development of alternative programmes and options for action. This set the paradigm of TA as an information service, offering possibilities for activities but no prerogatives, in other words, to answer the what ‘can’ be done instead of what ‘should’ be done. It is not a coincidence that still nowadays the European Parliament’s own TA bureau is called “Science and Technology Options Assessment”[1].

Soon after, European TA took up the US paradigm immediately and developed it further as it quickly became evident that TA cannot operate as hazard or risk analysis alone, if it is to provide functional policy advice. Classical TA was geared towards technocratic solutions to technocratic problems, but S&T had already become a social issue with considerable impact on the environment and the economy. Society changed from observer to participant and from recipient to actor. In this light, TA had to evolve towards new objectives and new methodologies to account for this change. What was then termed “participatory TA” was the answer to this necessary evolution. This new form of TA allowed for more complex analysis of S&T developments and a wider participation of actors.

Overall, TA was and still is, problem oriented research that aims to contribute to solutions of political, social, economic and environmental issues that are caused by S&T developments. The classical TA approach of transforming a scientific problem to a scientifically manageable research programme, has now been enriched with the inclusion of value-based criteria of analysis, that might or might not lead to a scientific solution. The idea of value neutral scientific advice and political decision-making cannot be kept up in modern societies. In this sense, the development of participatory TA is an effort to include these values in decisions and thus have a greater impact by involving society itself.

But even the spectrum ‘classical – participatory’ has not been able to satisfy the complexity of S&T challenges the world is faced with nowadays and the need to find sustainable solutions. TA methodologies have incorporated more innovative ideas in the effort to analyse the issues it deals with. Eclectic approaches such as constructive TA (Schot & Rip 1997), interactive TA (Grin et al. 1997), prospective TA (Liebert & Schmidt 2010) or, real-time TA (Guston &

1 http://www.europarl.europa.eu/stoa/

Sarewitz 2002), have gone beyond the 'classical/participatory' dichotomy to develop action-oriented TA that has higher policy relevance.

If one should provide a categorisation of the modern TA state-of-art, three main areas of TA functions can be identified: TA as policy advice, TA in public debate and TA in engineering contexts (following Grunwald 2018).

TA as policy advice: This is the original aim of official TA since the times of OTA, i.e. to support policy-making by providing comprehensive and independent advice. This type of TA covers all technology aspects of public interest with particular focus on health and the environment. It aids in the identification of research priorities and the setting of the framework of innovation policy. This is the realm mainly of parliamentary TA that has seen considerable development in Europe, although the executive branch whether at national (e.g. ministries) or regional (e.g. municipalities) level has also taken up TA.

TA in public debate: Participatory TA is a category by itself as it involves a different paradigm of decision making than the standard policy ones. It is based on the view of citizens as active contributors to policy and policy itself as the result of deliberative democracy. This is an ideal view that incorporates all interests and values in an open public sphere of exchange and knowledge creation (Habermas 1992). The assumption in participatory TA is that both the effect and the legitimacy of the decision increases if the public is involved in the process.

TA in the engineering process: This type of TA encourages interdisciplinarity in the whole process of innovation. From the inception and design to development and market placement, TA plays a key role by enriching the process via a continuum of assessment. Reflexivity over possible consequences and account of a broader spectrum of values, helps the construction of quality engineering and can increase its societal and even economic worth (Guston & Sarewitz 2002).

So, what is actually TA? There is no such thing as a common definition since it is an interdisciplinary undertaking that seldomly had the opportunity to gather its great variety of expertise under a single entity. One such rare occasion under the European project "Technology Assessment; between Method and Impact" (TAMI)[2] produced the first ever common TA definition:

> *Technology assessment is a scientific, interactive and communicative process which aims to contribute to the formation of public and political opinion on societal aspects of science and technology. (Decker & Ladikas 2004)*

This definition contains many substantial aspects of modern TA. It refers to "opinion forming", not just "opinion informing" since it includes in its core competences the analysis of values and the participation of wide stakeholder representation. Although still true to its origins as a "scientific" process, it is also a "communication" process that aims to provide the means to overcome impasses in social debates. As such, TA not only does risk assessment, but also builds bridges between opposing views and values. Moreover, it is an "interactive" process because it sees interaction between disciplines and experts as key to its method. Finally, TA is a "social" endeavour as it focuses on aspects of technology which are relevant for society, whether in terms of ethics, environment or economics.

1 The Roles of Technology Assessment

In order to be able to compare the TA state-of-art across the globe, one needs more than a common definition. What TA does is a result of a number of pa-

[2] TAMI was a project European project from 2002-2003 focused on providing a basis for discussions on the methods and impact of TA. It brought together a unique group of European TA institutions and experts to systematically analyse TA activities and basic functions. For details see: https://www.itas.kit.edu/english/projects_grun02_tami.php

rameters that delineate its functions in a specific place and time. Before analysing these parameters, we need a common framework of TA functions that encompasses all possible aims and remits that TA could possibly have, in other words, what roles TA has across the globe. Following the consensual process of devising a common definition, the same group of TA experts have identified a common framework of TA functions (Hennen et al. 2004). Below is a matrix that shows nine types of impacts of TA and an inventory of 21 roles or functions of TA in policy making, developed by TA-practitioners.

Table 1: Typology of Impacts (from Hennen et al. 2004)

Impact Dimesion/ Issue Dimension	**I. RAISING Knowledge**	**II. FORMING Attitudes/ Opinions**	**III. INITIALISING Actions**
Technological/ Scientific Aspects	Scientific Assessment a) Technical options assessed and made visible b) Comprehensive overview on consequences given	Agenda Setting f) Setting the agenda in the political debate g) Stimulating public debate h) Introducing visions or scenarios	Reframing of Debate o) New action plan or initiative to further scrutinise the problem at stake p) New orientation in policies established
Societal Aspects	Social Mapping c) Structure of conflicts made transparent	Mediation i) Self-reflecting among actors j) Blockade running k) Bridge building	New Decision Making Processes q) New ways of governance introduced r) Initiative to intensify public debate taken
Policy Aspects	Policy Analysis d) Policy objectives explored e) Existing policies assessed	Re-structuring polcy debate l) Comprehensiveness in policies increased m) Policies evaluated through debate n) Democratic legitimisation perceived	Decision Taken s) Policy alternatives filtered t) Innovations implemented u) New legislation is passed

There are three overall dimensions of impact that TA could be expected to have: impact in the sense of **raising knowledge** on issues among policy makers or in public debate, impact in the sense of **forming opinions/attitudes** of actors involved in policy making and the debate, and impact in the sense of **initialising actions** taken by policy makers or other actors.

These dimensions are interlinked with the dimensions of the issues that TA is expected to generate knowledge about. It has to deliver comprehensive and unbiased information on the **technological and scientific aspects** of the issue that is at stake and in order to do this it must describe the **societal aspects**, meaning providing knowledge about the relevant actors and the possible social conflicts that can evolve around the technology under consideration. Furthermore, it must analyse the **policy aspects** of the problem and develop policy options.

Raising Knowledge represents the classical TA functions. It refers to the perceived deficit in knowledge of scientific facts that is sometimes seen as the cause of issue at stake. The three roles in the column Raising Knowledge are directly related to the content of the TA process and its outcome; these make relevant actors aware of new aspects of the issue. Examples of this are scientific knowledge on paths of technology development, risks, chances, unintended consequences etc. (**scientific assessment**), interests or perspectives of actors involved (**social mapping**) and problems and options of policy making (**policy analysis**).

TA is also a learning process amongst actors that not only raise their knowledge level but also change attitudes and opinions about the issue at stake. Forming Attitudes or Opinions is thus another role that TA can play. Changes in attitude may occur with regard to new scientific aspects which are now discussed among policy makers or in public debates (**agenda setting**). It may happen that the TA-process or outcome change the way that the relevant actors see each other or deal with each other (**mediation**) or that options for policy making are seen/discussed in another way or that new options become prominent on the agenda of policy making (**restructuring the policy debate**).

Initialising Action means that a TA process influences the outcome of the policy making process. Regarding the scientific aspects of the issue at stake a TA-process may lead to **new R&D policies**, such as initiatives to further scrutinise aspects of the problem. With regard to the societal aspects (e.g. actors, conflicts) policy makers may conclude from a TA-process to initialize **new ways of decision making** (e.g. to set up a programme of public discourse or include social groups in the decision-making process). Apart from such initiatives which can be seen as new forms of dealing with a problem it might well be that TA leads to a definite **political decision** (in the sense of closure of debate): e.g. to implement a technology that was scrutinised with regard to its pros and cons, or to set up legal rules for implementation.

2 Towards a Global Technology Assessment?

As the evolution of TA described above shows, it must react and adapt to continuously changing situations in which S&T take place. A next step in this is the global level. The aim of developing a global approach for TA comes from the growing need to assess S&T on a global level. This in turn emerges through a situation in which S&T are becoming more and more widespread in their development and effects. Technologies extend worldwide and influence the lives of people in very different countries or cultures almost simultaneously. Therefore, when looking at most developments (economic, cultural, technological, social, etc.) in our world today, the concept of globalisation is inevitable in order to better understand how these actually take place. Studies on the increasing global scope of changes have emerged since the 1970s, focusing on various developments such as the rise of a global economy, global cultural practices, political processes on a global level, the worldwide movement of people including new forms of identities and communities as well as new social hierarchies and forms of inequality (Robinson 2007: 125). The analysis of these global issues has been done in numerous areas ranging from social sciences, history to law and natural and applied sciences. Overall, globalisation can be described as the intensification of social relations across the world, which links the local to events happening far away and vice versa (Giddens 1990). Yet, whether globalisation is a process or a condition, whether it is mainly economic, cultural or political remains contested (Robinson 2007: 127).

In light of global effects of science and technology as well as global challenges there is an increasing need to find methods and frames for coping with, but also shaping these developments. Next to more or less established forms of national TA, this calls for a searching of global approaches. The frame of TA is the orientation based on the problem at hand, which then determines the methods used or the addressees targeted. From the increasing relevance of global effects and challenges comes a further problem orientation for TA: How to respond to these (new) global transformations? In the context of global S&T developments and effects as well as challenges what forms of global TA are needed and what can a global TA framework look like? Scaling TA up to a global level also means to look for common ground: Which aspects of debates can be found in all countries or cultures dealing with S&T developments? But at the same time to look at how TA (or TA-like activities) are understood differently in countries.

Accounts on the shortcomings of TA[3] and possible new forms can be found, especially in relatation to sustainable development (Ely et al. 2011). TA has the potential to help prioritize and identify more effective or sustainable S&T policy decisions, but the critique here is that conventional TA often does not deliver, especially in the so-called developing world. In this case, TA, as a Western concept, may tend to give inadequate accounts of the existing social,

[3] General shortcomings and critique, especially of parliamentary TA can be found related to the first Office of Technology Assessment (OTA) established 1972 by Congress in the U.S.A. Here is was claimed that OTA lacked objectivity, was slow in assessing, limited view of consequences (focusing more on economic ones than on ethical or social effects) or lack of stakeholder involvement (Ely et al. 2011: 17; for more on OTA see for example: Bimber and Guston 1997).

technical or environmental situations or uncertainties and miss local power structures that shape S&T developments. This means that new forms of TA are needed, ones that "position technologies within dynamic pathways of change at the system level, recognise alternative understandings of these systems by different groups within society and attempt to build resilience in the face of pervasive uncertainty" (Ely et al. 2011: 10). These new models of TA should adapt to the world around them. They should combine participation of decision makers with citizens and technical experts. Moreover, they should be networked rather than central in their location (e.g. an office of TA). This can enable an opening of the output provided by TA to wider policy discussions as well as bringing wider inputs into the assessment[4]. The global level of new models of TA can be achieved through the inclusion of an array of organisations throughout the world, that can be included in TA activities. This idea goes beyond the old TA concept of a country-based and government-led activity, and redesigns it towards "more transnational, networked, virtual and flexible" (Ely et al. 2011: 21).

The apparent challenge of TA in today's world can be regarded as the need to be applied at a global level of assessment and result in corresponding global policies. Yet, this raises new questions in terms of how TA methods are able to incorporate and deal with numerous cultural differences, and what TA formats could have the potential to be useful in various cultural contexts?

3 Towards a Global TA Framework

The above shows the apparent need for a global TA. Based on this thinking, we need to further specify the parameters that effect such a possibility. In other words, what influences the creation of a common functioning TA across

[4] One example of a wider inclusion and taking action regarding technology development especially in the developing world is the Appropriate Technology Movement (Hazeltine & Bull 1999; Pearce 2012 or http://apptechdesign.org/).

the globe? As we have already witnessed in Europe, there are certain dynamics that are particularly important in the development of TA. These are contextual influences that delineate the positioning and function of TA. As our aim is to develop a common TA framework, it is vital to reach as much commonality as possible in the context that TA functions in. This is needed in order to be able to develop meaningful national comparisons, but also in order to be able to approach the analysis of common challenges on equal footing. This is not to say that we argue for an identical TA around the world; that would simply be impossible and not desirable. We should nevertheless strive for a critical mass of commonalities that can create a common framework in which TA can function.

Institutional Setting

Commonalities can be found in the way that TA is understood and structured across the globe. The institutional setting of TA is one aspect that deserves attention since it has significant repercussions on how it is viewed and functions. This refers to the particular organisational structure of the TA institute (or similar organisations), such as the mission, location in the decision-making system, clientele and image (Cruz-Castro & Sanz-Menendez 2004).

The foremost contextual parameter is whether the TA institute is directly attached to the national legislature, i.e. whether it is "parliamentary TA". In Europe, there is a number of TA institutes that belong to the official national legislature structures, prominently in Germany, France, Norway and Switzerland. No such TA settings exist in non-European legislatures. Alternatively, the TA institute could have a more independent status as an academic research institute with an additional policy advisory role. The difference in this setting creates clear limitations in the TA process and the impact of its work.

It is important to note here that the content of the work does not necessarily change due to the location of the institute. We have examples of parliamentary institutes that are very active in initiating public debates, running participatory processes and function as bridge-builders (e.g. in Norway) and also non-parliamentary institutes that focus on S&T analysis and options assessment via research programmes (e.g. in Germany). This diversity though does not invalidate the overall distinction, since the main client is different in these cases: a parliamentary office can only work on issues that are of interest to the national parliament and in ways that the members of the parliaments have sanctioned. And although by no means guaranteed, there is normally a direct input in the decision-making process.

Policy paradigm

The policy system that dominates the country in which TA is functioning, naturally poses strong influence in its functions and working dynamic. This does not necessarily refer to political economy, since nowadays it is hard to find direct connection between political economy and S&T developments. This is not to say that S&T is free from ideology; far from it. But the facts show that whether nominally communist or capitalist, central planning or free market led, a country that advances its S&T system faces similar issues and challenges. The policy system affects the way that TA works via the decision-making structures and the main actors in them, in other words in the way innovation is conceived and promoted.

State versus market driven innovation, is a basic distinction that has a direct impact in TA functions. Where the state is the prime mover of the innovation system, public organisations have the main say and are the main funders of S&T developments. TA, as an established public service with independent scientific credentials, has a key role in influencing policy-making. Its proximity to the state can be a benefit in such an innovation system, so long as its independence can be assured. State-driven innovation should ideally be geared towards the public good, free of political bias, and this can provide TA with a direct influence in policy-making.

In a market driven innovation system, S&T developments are led by private initiatives. Profit is naturally the main motivation, but this need not be in conflict with the public good. Market decisions are influenced by social needs, therefore issues of risk, acceptance, sustainability and fairness play a significant role. TA plays a double role here: either as an independent assessor tasked by market forces or as a legislative advisor on the behest of public bodies. In any case, in a market driven system, hazard identification (for health or the environment) are predominant issues in the TA process.

Values systems

Similar, but not identical, to the policy system, TA is influenced by the dominant values that are evident in each society. By values here, we mean the standard social norms of behaviour and the overall understanding of right and wrong. This is usually expressed through traditions, religious beliefs or political ideology. This is a context that cannot be disregarded when analysing S&T developments and attempting to provide realistic and sustainable options for action. Although this is not a straightforward undertaking and it also requires input from additional social scientific disciplines such as anthropology, political sciences and sociology, the analysis of the dominant values in society that influence the views and debates on new technologies, is a necessary ingredient in a global TA. In-built in this process, is the study of basic cultural influences in S&T developments that can be undertaken through the analysis of key policy documents (e.g. constitutions, strategy papers), relevant surveys (e.g. on S&T ethics) and input from key actors (e.g. Ladikas et al. 2015).

Innovation Development Stage

The state of the innovation trajectory in the particular area of analysis, is another important factor in the operation of comparative TA. This refers to the concept of timing in the innovation process and how that effects the assessment of new technologies. As a rule of thumb, the earlier TA enters the innovation trajectory, the more possibilities there are to shape the future of the technology at stake, but at the same time, the more partial and imprecise the available information is. On the other hand, the later TA enters the trajectory, the more complete and comprehensive the knowledge over the technology is, but at the same time, there is less influence in the innovation strategy.

There is no obvious solution to the problem of timing and it is also not directly related to institutional settings. The location of the TA institute in the decision-making structure does not necessarily help it to identify the right time in the innovation trajectory for assessment. It is actually not uncommon that policy structures are too inflexible to recognise the potential trajectory of a particular technology and as a consequence, are not able to initiate a policy relevant TA analysis. A possible solution is to be found in enhancing the internal institutional flexibility to take advantage of individual experience and knowledge of the innovation context.

Science and Technology Priorities

Not every country has the same S&T priorities. Despite the fact that there are so many global problems that need global solutions, each country also has unique needs that require specific solutions. Technological development is interlinked with socio-economic development and although there is no rule on which technologies are appropriate at which stage of development, there are certain commonalities that need to be taken into consideration. For instance, nanotechnologies are providing countless opportunities for product development but also result in very similar challenges (e.g. unintended health or environmental hazards) that TA is required to assess. At the same time, countries like Germany develop health applications (e.g. drug delivery) while other countries, like India, focus on environmental applications (e.g. water filters). The reason for this discrepancy is simple: different needs and expectations. A global TA has to take into account the different priorities created by different socio-economic needs, which in turn result in different challenges.

4 The Scope of this Book

It is clear we cannot provide in this book a definitive global perspective but instead, ‘a’ global perspective. To start with, global perspective means full global representation that we do not have in this book. It also requires empirical research that we do not undertake here either. What we do is open up the discussion by describing how TA is being done in a number of key countries with intensive S&T programmes, and offer perspectives on how a global TA could be applied and which vital ingredients it should have.

China, India, Australia, Russia and Germany have been chosen as case studies in TA. There is an obvious reason for this: all these countries have a strong S&T sector and economies that are partially, if not predominately, based on it. The need for TA is evident and they represent a spectrum of TA developments. From countries with a strong, well-established TA presence (Germany) to those with limited experience in it (China, Australia) to those with little knowledge in it but with experience in similar processes (India, Russia). They also represent very different policy systems, cultures, values and socio-economic trajectories. These are all key issues in our inquiry.

One can reasonably argue that there are other interesting countries, representing different TA experiences, policy systems or cultures. Countries that one cannot disregard in a global TA perspective. This is of course true and there is a slight ‘EurAsia’ bias in the choice of countries. But one should start from somewhere and our choice is very useful for the purposes of this book. If one understands how TA functions in such diverse countries, then one can start devising a common global framework. This is the first step towards a global TA. This is our aim.

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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/weodata/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-

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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 consequences 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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European Concepts and Practices of Technology Assessment

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Europe and the European Union are interchangeable terms when it comes to understanding the Continent and attempting to uncover a common culture and approach to policy making. This assertion stands true at least when seeing Europe from the outside and providing a description of the world's state-of-art on a particular issue. Many people would disagree that Europe has a common cultural entity and would point to a myriad easily evident cultural and political differences on the Continent to prove the point. Nevertheless, no one can dispute that there is a common cultural inheritance and history across Europe and that most differences we witness can be balanced out by commonalities. Proof of this is nothing else than the existence of the European Union itself. A union covering more than 80% of the Continent in a borderless area with common decision-making bodies, is a testament that Europe can indeed be seen as a common entity in world affairs. Therefore, it is acceptable to refer to European ways of "doing things" by using the European Union as the main unit of analysis.

When it comes to Technology Assessment (TA), this argument is even more accurate since S&T policy is evident in the European Union as much (or even more so) as within the individual member states. Where decisions and budgets are concerned, the EU runs one of the biggest science and technology (S&T) research budgets in the world and develops legislation that is adopted by all member states, thus, making it the most important actor in this regard on the Continent. As such, the EU has developed its own analytic and advisory structures, including specific TA-focused ones. On the other hand, it is still a grouping of independent countries that have their own views and priorities on S&T and as well as specific TA capabilities. But this fact does not negate the other and in reality, the actual actors and processes are, more often than not, the same in individual countries as in the EU. Based on this thinking, one can clearly deduce a European TA with specific European characteristics. These will be analysed below.

1 Science and Technology Policy Structures in Europe

As an amalgamation of independent states with varying degrees of S&T capabilities, one should provide a brief overview of national aspects as well as EU ones. In terms of research and development (R&D), gross domestic expenditure in the EU in 2016 was EUR 303 billion (a 0.4 % increase on the year before, and 40.0 % higher than 2006). In terms of world comparison, in 2015 R&D expenditure in the EU was 66.6 % of that recorded in the United States, and 48.5 % higher than in China, more than double the expenditure in Japan, and more than five times as high as in South Korea (Eurostat 2018). The individual country expenditure varies greatly from more than 3% (R&D expenditure as percentage of GDP) in Sweden and Austria, to less than 0.5% in Latvia and Romania. In fact, one can deduce a north-south, west-east divide when it comes to R&D expenditure in the EU, where the Northern countries have higher expenditure than Southern ones, and Western more than Eastern ones. The source of R&D funds varies amongst countries but on average more than half (55.3 %) of the total expenditure is funded by business enterprises, about one third (31.3 %) is funded by government, and about 10.8 % from abroad (foreign-sourced funds).

Decision-making structures in S&T also vary from country to country yet certain commonalities can be found. Most national public funding is channelled through the Ministries of Science to research councils and universities, however regional authorities also play a role in funding and deciding on S&T policy. National Research Councils or Associations usually administer the bulk of the public R&D funds through competitive grants that are mainly absorbed by universities, research centres and small/medium enterprises. Decisions on allocation are usually done through expert, peer review systems that nowadays are mostly international in nature. National decisions and R&D evaluations commonly include the participation of European or even international experts. This, in addition to the fact that most national R&D projects include international collaborations, shows how far national S&T structures are interwoven in the European system.

At the European Union level, S&T policy is undertaken through specific and unique structures. Central amongst them is the European Commission, (EC) the executive branch of the European Union. With a wide remit akin to a government cabinet and about 32,000 civil servants, the EC is the most powerful decision-making body in Europe, also in the area of S&T. The Research and Innovation Directorate General is responsible for S&T policy and an annual budget of ca 10.1 billion Euros. Most of the budget is dispersed in the form of competitive research grants with a clear purpose to foster European cooperation. As such, grants request collaboration between institutes and businesses from a number of member states and most of them will involve consortia with ten or more individual member state representation.

Another key EU research funder is the European Research Council (ERC). ERC is an independent organisation to the European Commission, with a budget of ca 1,3 billion Euros and a remit to promote European R&D through individual funds to be spent within Europe. Competitive calls disperse grants to individual experts, from anywhere in the world, to undertake research in Europe. Wide European collaborations are not obligatory, neither the focus of research has to be in Europe. Only the location of the individual must be in Europe as this is seen as another way of promoting European S&T excellence through individual expertise.

Furthermore, even the briefest of European S&T structures description would be insufficient without mentioning the European Parliament (EP). The EP is the legislative part of the European Union with a remit similar to any standard Parliament in a parliamentary democratic system. Debates on S&T issues are enacted in the EP, relevant legislation is approved and the final budgetary decisions for the entire EU are also made there. The main responsibility in the S&T area lies within the Committee on Industry Research and Energy that has about 45 members representing all EU member states. Significantly, the EP has its own independent TA advisory structures as described below.

Finally, one should also include the Council of Europe as another player in S&T developments in Europe. As an international organisation with 47 members, representing the whole of the European Continent and founded in 1949, the Council of Europe's aim is to uphold human rights, democracy and the rule of law in Europe. Despite this vague set of goals, the Council of Europe has been active in debating S&T developments and has designed influential guidelines in the fields of biomedical research, genetics and biotechnology (Council of Europe 2018). European TA is active in the Council of Europe as it relies on established TA institutes for advice.

2 Science and Technology Priorities and Values

Describing the fundamental values that underlay S&T policies in Europe as part of a European cultural identity – beyond the diversity of the many nation states that form Europe geographically – one can easily trace back to the world views and beliefs that are basically rooted in the Greco-Roman and Judeo-Christian traditions shared by all European nations, which centrally involve respect for the rights and dignity of the individual human being. This tradition continued throughout the European Enlightenment in the 18th Century which set out to free the individual from all secular as well as religious authorities and dissolved the individual to independently guide their action by nothing else than the in-born reason. The values and concepts that form the core of the EU charter of Fundamental Rights that was made legally binding by the European Union's Treaty of Lisbon in 2007 are clearly rooted in this humanist tradition. Taking the values and concepts addressed in the charter as a proxy for "the European value system" Schroeder and Rerimassie (2015) have shown how values such as justice, solidarity, equality, dignity and citizen rights (all connected to the appreciation of the rights and needs of the individual) can be identified as guiding principles in S&T policy. This is also evident in recent public discourses about the right way to shape scientific and technological 'progress' in a socially sound, publicly acceptable, or ethically justifiable way and thus, in the best interest of the 'common good'. This not only applies for the obvious prominent role of the concept of 'human dignity', for instance in recent debates about modern bio-medical options (such as gene-therapy or human in-vitro-fertilisation and embryo research). It is also relevant for societal discussions about a 'just' social distribution of benefits and risks of innovation processes, about 'equal' access to the benefits of advanced technologies, or about 'citizen rights' in the governance of new technologies and in protecting themselves or their living environment against un-intended impacts connected to technological innovations.

As part of the European value system relevant to S&T policy, one must add to these concepts – as Schroeder and Rerimassie do – a more recent appreciation of nature and natural resources. This ranges from the "Silent Spring" discussion in the 1960s to recent climate change policies and its implications for energy policy in the 2000s. Nowadays the value of 'nature' is widely accepted and addressed as a guiding principle of S&T as indicated in the political concept of sustainable development and in the legal enforcement of environmental protection in private and public administration and management. Besides this, it goes without saying that individual freedom as a heritage of Enlightenment and an achievement of the European bourgeois revolution is historically connected with freeing S&T development from restrictions of religious beliefs or governmental barriers. Enacting research at the frontiers of human knowledge, investing in innovative technologies, striving for new technological options that open up new markets is regarded to be an indispensable part of human freedom and driving force of social welfare. This is mirrored in the many private investments of R&D companies and in public R&D programmes on the EU level as well as initiatives of the national European governments in areas such as Biotechnology or Information Technology.

Thus, one may say that both the continuous effort for innovation and technological change as well as the protection against its possible ethically unintended consequences, are rooted in the value system evident in European culture. This, beyond socio-historical reflections, can be seen in the "Lisbon Strategy" that accompanied the ratification of the Lisbon Treaty on the European Union (2007)[1] and has been continued by the current "Europe2020 strategy"[2]. The agenda of the European Union as formulated in these documents, clearly underlines the European claim to be one of the leading innovation hubs globally and declares that increasing the global competitiveness of the European research area and economy is the foremost goal of European S&T policies. On the other hand, the Precautionary Principle is prominently featured in the Treaty on the Functioning of the European Union (Article 191) as the guiding principle for protecting European citizens' health and the environment. The application of the Precautionary Principle is justified as follows: "where scientific data do not permit a complete evaluation of the risk, recourse to this principle may, for example, be used to stop distribution or order withdrawal from the market of products likely to be hazardous." (EC 2000). The principle "may be invoked when a phenomenon, product or process may have a dangerous effect, identified by a scientific and objective evaluation, if this evaluation does not allow the risk to be determined with sufficient certainty" (EC 2000).

1 http://www.europarl.europa.eu/factsheets/en/sheet/5/the-treaty-of-lisbon
2 http://ec.europa.eu/eu2020/pdf/COMPLET%20EN%20BARROSO%20%20%20007%20-%20Europe%202020%20-%20EN%20version.pdf

The application of the principle implies a) thorough scientific evaluation of possible dangers and of the degree of scientific uncertainty involved in this, b) an evaluation of risks and potential effects of non-action and c) the participation of all interested parties in the evaluation of measures to be taken. The principle thus, can be seen as a reaction to the uncertainties implied in the ever-accelerating pace of technological progress by inducing thorough analysis and an inclusive democratic process of risk governance. Moreover, the application of the precautionary principle on a case by case basis (not as a general routine) also implies that the burden of proof (for danger or risk) is put on the maker of the products in question, who has to show their harmless nature. The Precautionary Principle has guided many regulatory processes in the EU – such as REACH[3] on hazardous chemicals or the regulations regarding Genetically Modified Organisms (GMO) – and manifests itself in many EU-wide regulations for environmental or consumer protection.

Furthermore, it can be said that the parallel or accompanying working of the enforced support of research and innovation on the one side, and the precautious protection against its possible negative consequences on the other, is not only a characteristic for the level of the EU S&T administration and governance, but is virulent also in the European member states and their S&T activities. The move to orient the current EU research framework programme towards and alongside great "societal challenges" (and not, for instance, alongside fields of technology or research) can be read as a formula to foster both. As progress in social welfare by increased research and innovation efforts oriented towards pressing societal needs and as the alignment of S&T with societal demands and expectations and the rights of the European citizens. Orientation of S&T towards society – or embedding science in society – in this double respect of demand driven R&D and societal governance of its course, are general features (including a broad scope of local interpretations) of R&D policy in Europe. This, however, should not allow us to forget that in

[3] Regulation concerning the **R**egistration, **E**valuation, **A**uthorisation and Restriction of **CH**emicals

each case, technology development is subject to societal and political debate on how a balance can be defined between innovative dynamics and global economic competitiveness on the one side, and demands for protection of negative affected values or interest of societal groups on the other.

3 TA State-of-art: Methodologies and Impact

Past drivers and prospects of TA in Europe

TA as a concept was established in the 1970s and 1980s in Europe and led to the development of institutions in academia, public administration and the private sector that are active in research on societal or environmental impacts of technologies as well as in advising policy making on S&T issues. The scope of institutes and research groups dealing with aspects of TA such as science and technology ethics, risk assessment and communication, science and society studies is very broad. The term Technology Assessment itself, however, is mainly used for activities focusing on policy advice. The success of TA in Europe after the establishment of the Office of Technology Assessment (OTA) at the US Congress in 1973 and beyond its closure in 1995, is represented by the establishment of the European Parliamentary Technology Assessment (EPTA) network representing 12 parliamentary TA institutions and the European parliament plus 10 associate members representing TA related institutions in other countries in Europe and beyond.[4]

Certain socio-cultural developments and structures in the 1970s and up to the 1990s can be identified as being conducive to the development of TA in (Western) Europe (Hennen & Nierling 2015). Firstly, in most Western European countries, there was a highly developed and differentiated R&D system with a strong and visible commitment by governments to develop and fund national R&D performance, mainly in order to improve or foster international

4 www.eptanetwork.org

competitiveness of the national economy. S&T was clearly regarded as a decisive factor of social development, which in the best interest of society had to be taken care of by the government. This was reflected in the setting up of specific structures in governmental administration (i.e. Research Ministries), growing public funding for R&D, as well as by increasing the salience of R&D issues in many standing parliamentary committees. Secondly, there was a strong and articulated public interest in S&T issues. Apart from a more generalised criticism against “industrialisation” or “consumerism”, citizen initiatives on every political level developed demands for a say in planning decisions and R&D politics. This was a reason why the issue of public participation in TA, right from the inception of TA in the US and even more later in Europe was a main aspect. Thirdly, problem oriented research and self-reflexive science gained importance in the academic sector, first in the field of environmental politics and later on in risk assessment and systems analysis in the social sciences (e.g. Science and Technology Studies, risk perception), and in ethics of S&T (environmental ethics and bioethics). The term ‘sustainable development’ served and still does, as a focus for interdisciplinary problem oriented research. Within these activities, there has been a visible and growing fraction of the academic sector advocating TA-like ‘hybrid-science’ and policy oriented research. An effect of these factors was a strong and explicit demand from the policy making side for support via the best available scientific knowledge in order to deal with public concerns. In some countries, this manifested mainly in demands for a particular support of the national parliament with best available and non-partisan scientific advice. In other countries, demands for stimulating a vivid (and well-informed) public debate and a better connection of parliament and government to ongoing public debates prevailed. This resulted in different forms of institutionalisation of TA bodies in relation to parliaments and governments (van Est et al. 2015; Enzing et al. 2012; Hennen & Ladikas, 2009).

Nowadays, Technology Assessment as a means of policy advice is widely established in many Western European countries. Otherwise, in Southern Europe and especially in the new European member states in Central and

Eastern Europe, TA structures are often missing or only weakly developed. One has to be clear about the fact that today the situation for Central and Eastern European countries is significantly different from the times that TA was originally established in Western Europe. Since the collapse of the 'Iron Curtain', Eastern European countries have been facing a great challenge in building up the socio-economic structures and political cultures that have been the norm in Western Europe for decades. As TA was a widely unknown term in these countries, the conditions for building up TA structures differ from those that initiated the development of TA in the 1970s and 1980s (Hennen & Nierling 2015). In most Central and Eastern European countries the main challenge remains building up new structures or fundamentally restructure existing R&D systems. In these cases, R&D policy has been busy setting up new funding structures (e.g. by establishing competitive instead of institutional funding) as well as new agencies for funding, promoting and evaluating S&T. Here, the R&D landscape is in transition and is less about 'protecting' societal needs and values against the dynamics of S&T, and more about instigating dynamics and exploring innovation paths to generate economic growth and to keep up with pressures of globalisation. Social impact of S&T comes into perspective less in terms of environmental or health risks and ethical issues, and more in terms of supporting societal welfare.

Nevertheless, the exploration carried out in during the Parliaments and Civil Society in Technology Assessment (PACITA) project[5] revealed that despite existing barriers, there is a role for TA in adapting and offering support with regard to existing deficiencies and problems of S&T policy making. Concerns about problems of S&T policy making often result in an explicit demand for 'knowledge-based policy making' for which TA is welcome as a means of underpinning decisions with best available knowledge in an unbiased manner. TA can significantly contribute to ongoing activities of modernising the R&D

[5] PACITA was a four-year EU financed project under FP7 aimed at increasing the capacity and enhancing the institutional foundation for knowledge-based policy-making on issues involving science, technology and innovation, mainly based upon the diversity of practices in Parliamentary Technology Assessment. http://www.pacitaproject.eu/

system by supporting the strategic planning of landscapes, evaluating capacities, or supporting the identification of socially sound and robust country-specific innovation pathways. Due to often poor transparent democratic decision-making structures in S&T policy making, which results in a lack of communication and cooperation among relevant actors (academia, government, parliament, CSOs), TA could find a role as an independent and unbiased player able to induce communication among relevant actors on 'democratic' structures. Other than in the 1970s and 1980s in Western European countries, nowadays S&T is generally far less an issue of a livid public discourse and activism of CSOs. Currently relatively low public engagement in S&T debates in Western Europe happens in an established system of professional and public authority bodies dealing with risk and ethical issues, which is often missing in Central and Eastern Europe. The capacities of TA to "stimulate public debates" (as particularly developed by the Dutch and Scandinavian TA organisations) may gain particular importance here.

Overall, in some European countries TA is in the making and has to define its role in relation to the specific challenges without merely adopting structures and concepts from Western neighbours. It is clear that institutionalising TA at parliaments or governments is not necessarily the next step. It might well be that in terms of institutional solutions, none of the Western European models realised so far are appropriate. Enabling an independent form, but at the same time keep a close exchange with existing S&T policy making is therefore desirable. In this respect, ideas like a TA network including different (governmental, scientific, societal) actors and bodies with more or less close relations to policy making, as well as a 'NGO model' for TA are on the table. In this respect, it is important for future activities to take into account the fact that TA can be supportive (and organised) on different levels of R&D policy making activities. The explorative endeavour of the PACITA project focussed mainly on the macro level of national bodies and authorities of policy making. Yet, supporting activities could also aim at the meso level of regional or local bodies or on the micro level of R&D strategies developed in industrial companies or individual research institutions. By initiating TA activities on different levels a "distributed structure" of TA could evolve that might be more appropriate for some countries, rather than aiming at establishing powerful TA organisations on the national level.

Concepts and methods of TA

TA has always been driven by two impulses: one relates to expert analysis and the other to public deliberation. Accordingly, two models of TA have been prevailed throughout its history: a policy analysis model and a public deliberation or interactive model. Both models play a role in Europe (Guston & Bimber 2000). When the Office of Technology Assessment at the US Congress was established, this policy analysis model was predominant and over time influenced the take up of TA in Europe in the 1970s (Vig & Paschen 2000). The deliberative or interactive model gained importance in Europe during the 1980s and 1990s. Nevertheless, both the scientific as well as the deliberative vein of TA are indispensable features and in most cases TA projects are a blend of the two. One could argue that e.g. in the Netherlands and in Scandinavian countries a more deliberative brand of TA is predominate, whereas in German speaking countries, TA stands for a more scientific (policy analysis) approach[6]. Of course, this should not imply that the respective other side would be completely missing in each case. For instance, in the Netherlands organisations such as TNO or Twente University have significant research activities on social and environmental impacts of new technologies, while many institutions active in the German speaking network also apply participatory or deliberative methods when carrying out TA studies.

Overall, TA processes in Europe involve scientific as well as interactive methods and procedures (Hennen et al. 2004; Decker & Ladikas 2004). Scientific methods such as Delphi surveys (for gathering multidisciplinary expert knowledge), modelling, simulation or systems analysis (for understanding socio-technical systems) or scenario techniques, as well as discourse analysis for evaluating and uncovering argumentative landscapes of political and public

[6] For a full account of the German-speaking TA network activities, see (in German) www.openta.net

debates, are widely applied. This is true not only in dedicated TA organisations or institutions, but also in a broad scope of public and private research groups and academic bodies active in sustainability research, transition research, environmental impact assessment and social studies in science and technology. In many European countries problem oriented research of this type is part of the public S&T portfolio and established in specialised research institutions as can be seen e.g. from the port-folios of public research organisations such as TNO[7] in the Netherlands, VITO[8] in Belgium, HGF[9] in Germany, ESRC[10] in the U.K., or INRA[11] in France.

Currently, many of the widely established interactive, participatory or dialogue methods have been adopted or even developed by European TA institutions, such as consensus conferences and citizen juries, stakeholder workshops, or scenario workshops. Meanwhile, beyond TA organisations, participatory methods are widely applied in S&T policy making by consultancy groups and other specialised private companies on behalf of public authorities and local governments[12].

In the following, we provide an overview on the state of institutionalisation of TA as policy advice, mainly at national parliaments and a discussion on the relevance of participation for S&T policy making with a focus on the EU-level.

TA as policy advice

TA's mission is not merely to do research of the potential impacts of technologies on society, but also to give advice to policy making regarding options for a socially sound implementation of technologies with a focus on social welfare as well as environment and health. The two constitutive veins of TA,

7 www.tno.nl
8 https://vito.be/en
9 www.helmholtz.de/
10 esrc.ukri.org/
11 www.inra.fr
12 See e.g. overviews supplied by the engage2020 project – www.engage2020.eu

the scientific and the deliberative, imply that it is established for relevant actors mainly as a way to build “bridges between science, society and policy” (Decker & Ladikas 2004). How these relations are structured and to what degree TA relates itself to policy making, science and society differs according to national context. Also, the different links between these spheres imply complex institutional and interactive practices. The level of TA’s involvement in S&T governance, the organisational level of S&T structures as well as the project level of knowledge co-creation involving different stakeholders, has been explored in detail for several European countries (van Est et al. 2015).

Nowadays, S&T policy making in European countries cannot be done without taking into account and trying to anticipate possible consequences of S&T, which in turn is relevant for setting up research funding programmes. Thus, most programmes include some type of risk assessment activity, research on sustainability aspects, and ethics that aim to include the interests and values of relevant actors. TA in this respect serves as advisor for governments on the national, but also on the regional level.

In Europe, research on the impacts of (new) technologies on society is represented in academic systems by departments, institutes or research groups in various manners, such as risk assessment and risk communication, social studies of science and technology, environmental research, sustainability research, etc. Programmes on TA are established as part of big public research institutions (e.g. HGF, TNO). Also among the so called “Joint Research Centers” of the European Union there is an institute active and specialised in the field of TA (Institute of Prospective Technological Studies). Beyond public institutions, TA or related studies are also carried out by independent private research and consulting institutions (e.g. Technopolis, Öko-Institute, etc.).

Here, we focus on the most visible type of TA as policy advice which is the parliamentary TA landscape in Europe. Ironically, by the time OTA was closed, TA – as an import from the U.S. – had already become a major success in Europe. Today the European Parliamentary Technology Assessment Network (EPTA) comprises 13 national parliamentary TA institutions including the TA body of the European Parliament while there are another five associate members with close relationship to their national parliaments[13]. Parliamentary TA in Europe took up the heritage of the OTA, but today differs from it in many respects, organisationally as well as with regard to methodology and mission (Vig & Paschen 2000).

Different institutional models are applied in different countries, depending on their political and/or parliamentary traditions and cultures (Fig. 1). In some countries (e.g. Finland and Greece) parliamentary committees for TA have been established which, according to their agendas, invite experts to their meetings or organise workshops and conferences in order to enable scientific support. In the case of France, the individual members of the committee carry out TA studies on their own and deliver the results in the form of reports to their Parliament.

In other countries parliaments have chosen a model of institutionalisation that is closer to the OTA model. Here, the Parliament runs a scientific office on a contract basis with a scientific institute (e.g. in Germany and at the European Parliament) or as part of the parliamentary administration (e.g. in UK) to which TA studies are commissioned according to the information needs of the Parliament. These studies may result in short parliamentary briefing notes or in fully fledged TA reports drawing on their own research and also on input from a number of external scientific experts and stakeholders.

A third type of a parliamentary TA body is characterised by close cooperation between parliaments and external independent institutes (and in some cases related to the national academies of sciences) that support parliamentary deliberations with policy reports and the organisation of workshops or hearings. Often this kind of arrangement involves an additional mission of the institute, which opens up the classical (OTA-like) TA setting of experts and policy makers to an additional third party: the wider public. The mission of TA then is not

[13] www.eptanetwork.org

only to support politics by providing in-depth and unbiased analysis of possible effects of S&T on society, but also to inform and intervene in public debates. This kind of orientation of the consulting process towards the public, stakeholders, societal groups or citizens, can be regarded as a European 'improvement' of the classic TA model. This model also viewed societal values and interests as an indispensable prerequisite of TA when evaluating technology impacts. For instance, contacts to societal groups in the form of interviews, workshops, etc. have always been part of TA processes. Nevertheless, in the new 'public' or 'interactive' model of TA, society plays a more active role and participatory methods have been systematically developed and applied in order to give the public a voice in the TA process, while at the same time initiating and stimulating public debates about the issues at stake.

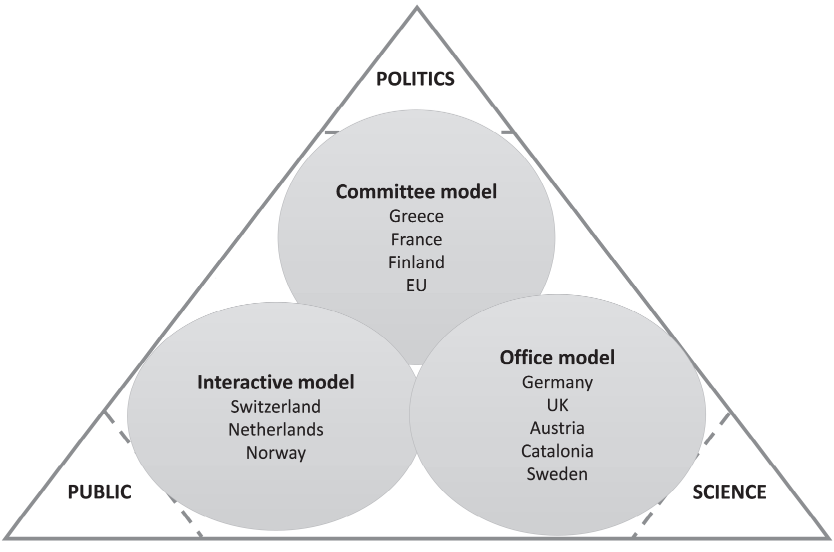

Figure 1: The intermediate role of parliamentary TA in Europe (adopted from Hennen & Ladikas 2009)

Against the background of these three models of institutionalisation – the “committee”, the “office“ and the “interactive” model – it is apparent that TA in Europe plays an intermediate role with regard to three societal arenas: science, politics and the public sphere. Which of the three models is the focus, varies according to dominant political cultures. However, any TA institution has to position itself in this triangle and can have the role of translator or mediator between science, society as well as policy making at the same time. Working according to the more ‘classical’ model of scientific policy consulting does not imply a ‘closed circle’ type of policy advice where experts and policy makers negotiate behind closed doors. The TA process must always be transparent to the general public and especially to stakeholder groups of specific issues. As a matter of fact, any TA study must be available for public use. Further, TA with a focus on intervention in public debates – by e.g. organising citizen conferences or setting up lay panels – cannot function without independent scientific expertise and will be politically meaningless without involvement of related policy making bodies.

TA in public debate (participatory TA)

The search for new forms of governance in the field of S&T is ongoing in Europe, as perhaps everywhere. This includes a redefinition of the role of scientific knowledge and experts in policy making (“democratising expertise”) as well as of that of the citizen or the general public. This implies that the role of the citizen does not only comprise civil, political, and social rights, but also rights with regard to the development of S&T. Technological citizenship is related to the tendency of seeing aspects of life that were formerly non-political, as politically relevant now. The development, diffusion, and implementation of technologies is increasingly regarded as a political issue due to their immense impact on society. Lay people are not only affected by S&T as clients or consumers, but also as members of a polity (citizens). This so called “participatory turn” has been an ongoing feature in many Western democracies (Jasanoff 2005). In Europe however, it is closely tied to the establishment of TA institutions in the 1980s and 1990s and has been sustained significantly by parliamentary TA institutions (Joss & Bellucci 2012). Particularly focused on participatory TA are the Danish Board of Technology Foundation and TA-Swiss, which have established a number of activities organising citizen and stakeholder engagement on TA related issues.

A redefinition of the role of citizens, however, is not only been visible on the national level. In the last 20 years, a series of documents and actions on the European level mark a remarkable shift from the previously predominant traditional Public Understanding of Science (PUS) “deficit model” to a new appreciation of citizens and their views of ethical problems and the risks related to new technologies (Allum et al 2008). There are indications that the predominant technology-driven approach to S&T policy, which includes an instrumental model of TA, has been enriched by efforts to steer S&T in a new direction by making societal needs and demands a part of research agendas. A point in case is the call for dialogue, participation, and empowerment of the European citizen in the EU “White Paper on Governance” in 2001 (EC 2001a). Starting from the observation “that people increasingly distrust institutions and politics,” the white paper suggests to “open up policy making” in order to render it more inclusive and accountable. The relationship between science and society is regarded as being crucial in this respect. A report by the white paper working group “Democratizing expertise and establishing scientific reference systems” (EC 2001b) contains the following recommendations: revise the selection of expertise used in the process of policy making, establish guidelines for the selection of expertise, and enable inclusion of a spectrum of expertise in policy advice that is as broad as possible. Most prominent among the recommendations regarding socially robust knowledge for decision making is the creation of opportunities “for informed participation by society in policy making”. The promotion of participatory procedures (such as citizens’ juries and consensus conferences) is one of the means to be employed to support “public debate, knowledge sharing and scrutiny of policy makers and experts” (EC 2001b: ii). The European Commission took up this reorientation in S&T governance in its Science and Society Action plan (EC 2001c), part of its activities to establish the European Research Area. The action plan recommends actively involving people in technological development, “particularly in defining the priorities of publicly funded research” (EC 2001c: 8). To this end, participatory policy making would have “to be widened and deepened to systematically include other sectors of civil society at all stages” (EC 2001c: 14).

These indications that S&T policy in Europe is being opened towards the public have to be viewed in the context of the overall economic objectives which form the guiding perspective of Europe’s S&T policy and the European Research Area programme. As Levidow and Marris (2001) have argued, “the rhetoric of openness” does not indicate a shift to a “new contract of science and society” but rather a shift from conceiving the problem of technology controversies as being grounded in the “ignorance of the public” to a problem of trust in institutions (see also Abels 2002). This move is thus a way to re-establish trust in policy making by increased communication without giving up the expert dominated system of advice. Overall then, this is not meant to lead to a reconsideration of the goals and guiding principles of innovation policy, but to be a means “to restore the legitimacy of science and technology” (Levido & Marris 2001: 348).

It is however widely acknowledged by experts as well as by representatives of the European Union that Europe is in need of a reorientation in order to react to criticism regarding the democratic legitimisation of EU policy making and of S&T policy in particular. Recently, new modes of political communication on the Internet, triggered initiatives by the European Commission to promote the use of e-participation as a means of overcoming the so called “democratic deficit” and to improve the connectedness of EU policymaking to the European citizenry. This led to several platforms and internet-fora as well as to the introduction of electronically supported public consultations on EU policy issues and finally, the establishment of the European Citizen Initiative that opened new ways for Citizens to be involved in EU policy making. The ambition, effects, flaws and prospects of these activities have been subject to various TA studies (Lindner et al. 2016; Korthagen et al. 2018).

Moreover, the influence of the concept of Responsible Research and Innovation (von Schomberg 2013; Stilgoe et al. 2013; EC Expert Group 2013) on the current EU research framework program Horizon2020 underlines the relevance of public participation in the context of European R&D policy. "Inclusion" of stakeholders and citizens beyond expert communities and economic actors as well as "responsiveness" to societal needs and demands are cornerstones of the concept and led to their inclusion in calls and funding schemes in Horizon2020 with particular emphasis on participation. The perspectives of public engagement in S&T policy and research on the European level have been subject to several EU funded TA projects[14] .

The widespread use of participatory methods in S&T policy making has however led to criticism among some TA scholars as well as political scientists. The relation and especially the influence of public engagement on policy making, has been subject of criticism in the last years. The criticism is based on more general reasoning about the political role and function of participatory TA procedures as well as on case studies of single participatory processes (for an overview: Hennen 2012). This criticism often refers to the unclear political role and function of public engagement with regard to institutionalised decision-making processes, whereby there is often a lack of commitment by policy makers to adopt the outcomes of public engagement processes. In addition, there is a fear that public engagement is instrumentalised by political interests for pushing through their own agendas.

It is true that due to the mostly informal status of participatory procedures in R&D policy making, participation is – like any other form of policy advice – subject to strategies of instrumentalisation and can be used for 'symbolic politics'. It should however not be ignored that participatory TA, as an element of deliberative democracy, has to act in an environment that is dominated by political cultures, institutions, and powerful actors that are often hostile to any restructuring of science and research policy making. Participatory TA

[14] www.engage2020.eu, www.PE2020.eu, www.CIVISTI.eu

makes up only one aspect of an ongoing movement toward more democratic structures in S&T. Thus, more recently, the tendency to overload participatory procedures with expectations of a reform of representative democracy has thankfully ceased. On the other hand, the role of participatory TA formats to inform policy making by perspectives beyond those of experts or politicians, have come to the forefront. Yet, these participatory procedures are regarded as a new form of governance, but not of political mobilisation (as some would like to see it).

Cross-European TA and European TA Networking

The integration of Europe as a trans-national entity has manifested itself in the European Union for more than five decades now. Meanwhile, the European Commission and also the European Parliament have achieved remits akin to a trans-national government. For many fields of policymaking nowadays, European Directives set regulatory standards for the EU's 28 member states as they have to be implemented by national governments. The EU's research funding programmes are significant drivers of research and technology development. The current research framework programme Horizon2020 comprises an overall budget for research funding of ca. 80 Billion € (2014-2020). It is quite clear that TA in Europe has to be more than just TA in several European countries, it needs to have a cross-European and trans-national structure. The integration of the "TA landscape in Europe" to a "European TA landscape" has been partly supported by the framework programs, which, since their start in the 1980s, included a budget dedicated to research on technology impacts and research ethics that instigated the co-operation of TA institutions across Europe. For many years cross-European TA has been supported by budgets dedicated to so-called ELSA (ethical, legal and social aspects) research in the EU framework programmes. Today the SWAFS (Science with and for Society) programme funds cross-European research on Science and Society problems that is also used by the European TA community. In addition, the European Commission's definition of Responsible Research and Innovation as a cross cutting re-orientation of research towards societal needs and anticipation and reflection on R&D's social effects, has supported the cooperation of TA actors across Europe. Projects that have been outstanding for cross-European TA activities over the last 20 years have been e.g. EUROPTA (Joss & Bellucci 2002), TAMI (Decker & Ladikas 2004), and recently the PACITA project as described below.

For a number of decades now, one of the focal points for the integration of European TA is EPTA, the network of parliamentary TA institutions (as described above). Many of its projects have been carried out with the support of or have been initiated by members of this network. EPTA has developed from a loose network of mutual exchange on ongoing activities, into a working network and has set up a number of joint research activities that resulted in reports and publications[15]. Barland and Peissl (2015) define cross-European TA "as TA (projects) done by a group of TA institutions across borders". It implies a common objective and cooperation but not necessarily the use of the same method and provide a list of several such projects that have been initiated by EPTA or have been jointly pursued by several EPTA members.

The Science and Technology Options Assessment Bureau (STOA) is the TA unit of the European Parliament (EP) and is a member of EPTA that, by setting up TA projects on issues relevant for the members of the EP, also constitutes a working area that affords cross-European cooperation of TA institutes. The European Technology Assessment Group (ETAG) as a joint endeavour of six TA institutions in Europe has been charged with several TA projects commissioned by STOA[16].

One of the most important achievements in further developing cross-European collaboration and networking in TA has been the EU-funded PACITA project (Klüver et al. 2016) that started from the assumption that TA will need to adapt to the internationalisation of science, technology and policy. The project's overarching goal was to mobilise and expand the European TA community through processes of mutual experimentation and learning. The aim of

[15] www.eptanetwork.org
[16] http://www.itas.kit.edu/etag.php

the project was to foster the development of TA into a Europe-wide support system for broadening the knowledge base of policy making in Europe by establishing a distributed system of 'cross-European TA'. In the four-year course of the project, it gathered a group of fifteen partner organisations from different European countries in a collaborative process. Among these partners, were some established TA organisations connected to parliaments or otherwise formally organised to support national policy (Austria, Belgium-Flanders), Denmark, Germany, the Netherlands, Norway, Spain and Switzerland), while others were organisations with closely related missions interested in developing locally appropriate institutional models for TA (Belgium-Wallonia, Bulgaria, the Czech Republic, Hungary, Ireland and Portugal). Activities of PACITA comprised the joint exploration of opportunities to establish lacking TA structures in various European countries. The project succeeded in introducing TA in these countries by motivating relevant actors to engage in discussions exploring barriers and opportunities for TA. Beyond that, the project carried out a series of summer schools and practitioners' TA training. Three major TA projects on issues of European relevance were selected for setting up collaborative TA projects that were carried out during the project period: aging society, genetic testing and sustainable consumption. Of major importance for fostering the exchange of policy makers across Europe was the organisation of two meetings of members of parliaments active in TA from several European countries. Another initiative was the construction of a European TA web-portal with project databases and contact points, that was organised alongside with the setting up of the German Speaking TA web-portal (Nentwich 2016).

With the organisation of two European TA conferences the project reanimated a tradition of European networking in TA going back to the 1980s and 1990s. A first meeting of the European TA community under the label of 'European Congresses of Technology Assessment' dates back to October 1982 when the Ministry of the Interior of the Federal Republic of Germany hosted a conference that attracted some 60 experts from eleven countries – among them were representatives of the US Office of Technology Assessment. Meetings on TA held later in Amsterdam (1987), Milan (1990) and Copenhagen (1992) contributed significantly to the conceptualisation, philosophy as well as institutionalisation of TA. These conferences made clear that the European debate on TA took place on several levels – between international groups of scholars, experts, and officials who held a series of meetings during which methods of TA, the utility of its results and the possibilities and problems of institutionalizing TA agencies were discussed. With two conferences held within the framework of PACITA (Prague 2013, Berlin 2015) a major step in further integrating the European TA community was achieved. These brought together researchers from 33 countries, fostered and enhanced the scientific debate about TA as well as the exchange of TA experiences on a European level. Adopting a broad understanding of what qualifies as 'TA' allowed the conferences to address TA practitioners, academics, scientists, policy-makers, and CSO representatives together. The conferences succeeded in offering on the one hand a broad platform for presenting and reflecting project results, its outcomes and new insights. On the other, they helped to set the stage for current and future thinking about TA and its role in tackling the societal challenges ahead. This spirit was taken up throughout the European TA community, which also shows in a further European TA conference which took place in Cork, Ireland in 2017[17] and was not funded through specific public support. There are efforts to continue this series of meetings of the European TA community bi-annually.

Despite the importance of such efforts to keep the European TA community in close contact and in an interactive mode, a stable, permanent exchange platform is missing. While there is sufficient motivation and a need to have a stage for debating TA issues and exchanging information on specific projects, there is still not a concrete plan for a regular European TA Forum.

[17] https://cork2017.technology-assessment.info/

TA in the engineering process (constructive TA)

TA in Europe is mainly related to policy making and thus to governments and public authorities. There have always been voices demanding an embedding of TA directly in research and development processes (Guston & Sarewitz 2002). Especially in the Netherlands, the concept of Constructive TA (CTA) aims to apply TA early on in research and technology development processes in companies and research institutes (Schot & Rip 1997). In this sense, CTA intends to broaden the process of technology development by including a broad scope of voices in the design of new technologies. This is for instance done by organising workshops with stakeholders from a broad scope of involved or possibly affected actors for developing scenarios of future implementation of a technology. The concept of CTA has been applied in the Netherlands by organisations such as the Rathenau Institute or TNO. CTA has mainly been applied in the context of public research programmes such as the Dutch programme on sustainable technology assessment (Vergragt & Jansen 1993) in the 1990s or the Dutch Nanotechnology Consortium in the early 2000s (Rip & te Kulve 2008).

There are also other approaches to include TA into the engineering practice such as the German Association of Engineers which already in the 1990s developed a directive for TA that gives guidance to engineers for reflecting on possible unintended impacts of a technology in order to adapt the design process in a way that allows avoiding such effects as well as taking expectations and fears of society into account (see chapter 2 on TA in Germany in this book).

Another approach to apply TA principles on the level of research and development processes directly is the concept of RRI, which demands the involvement of reflection on ethical questions and the inclusion of affected stakeholders as integrated part of R&D projects. In 2013, the UK Engineering and Physical Sciences Research Council (ESPRC) made a formal policy commitment to a framework for responsible innovation. One of the biggest funders of research in the U.K., committed itself and its funding activities to principles such as inclusiveness and responsiveness with regard to demands and expectations of societal groups as well as to reflexivity with regard to impacts and ethical implications of R&D (Owen 2014).

Generally, there are indications that industry is at least partly rethinking ‘closed shop’ or ‘closed laboratory’ strategies by opening up R&D processes to societal stakeholders and citizens. Several cases of involvement of CSOs as critical partners into the development of new technologies by industry are documented[18]. In these cases, stakeholder involvement is seen beyond a ‘product testing’ methodology, rather as a means to increase the effectiveness and social desirability of the technologies in question. Naturally, this increases the complexity of the innovation process by adding an external influence in the design stage and risking loss of competitive advantage by decreasing the usual secrecy surrounding product development. It is nevertheless sometimes seen as a risk worth taking for the greater future good. Although this is a new approach with hardly enough history to allow for impact evaluation, it is dynamic and ever-expanding.

4 Perspectives for European TA and Global TA

What we have described here as a “European TA” is in reality the main bulk of applied TA in the world. Few non-Europeans would acknowledge the term TA in their S&T context and even then, they are likely to be directly collaborating with European TA institutes. As such, the matrix of TA roles, which is described in the introduction and has been used in this book by our colleagues to map their national TA landscapes, is indeed a direct representation of European TA. It was developed by the main European TA players to describe their work and it remains still a good description of what TA is about in Europe.

[18] For instance http://www.responsible-industry.eu/ and http://www.rri-prisma.eu/

In order to juxtapose a European to a potential Global TA, one needs to take into consideration the unique aspects of the European TA that result in both pros and cons of its development. The biggest advantage for the European TA is that it can be seen as a microcosm of a global development. Europe is an amalgamation of countries, cultures, norms, values and political systems. Not long ago it was split into the clear sides of ‘East’ and ‘West’ that denoted sharply different political systems. Similarly, Europe is divided into a ‘North’ and ‘South’ axis that it is not conceptually different (at least in the mind of many Europeans) to that of the global North/South division. In addition, it includes a number of different languages and norms of behaviour that make interactions complex, if not outright difficult for many. All in all, Europe is a small ‘global’ entity, yet it has nevertheless achieved a certain TA commonality. One might argue that there is not much that non-Europeans can bring into the TA equation that European experts have not already discussed in their effort to unify it.

Nevertheless, European TA did not happen in a vacuum or as a simple desire to create a new idea. It was one of the myriad efforts that took place on the Continent to unify it under a single entity. The attempt to define a European TA must be seen in the context of the European Union and the great need to achieve common definitions and approaches. Without the will of the individual member States to promote and fund such attempts, there would be no ‘European’ TA. In the same thinking process, it is hard to imagine a similar global initiative that can create a Global TA. We lack a global government and the UN system can hardly qualify as a strong decision-making structure. As such, there is no obvious global platform that would be equivalent to the EU where TA can flourish. An interesting exception is the Technology Facilitation Mechanism that is promoting the UN sustainable development goals via TA processes[19] (See chapter 8 for further description).

[19] https://sustainabledevelopment.un.org/tfm

Another challenge in taking a European TA perspective for a global development is that of current differences in governance structures. Despite the various past differences, Europe is now a pluralistic, liberal democratic system of parliamentary representation. Multi-party free elections are as standard on the Continent as well as open public debates about any S&T issue, regardless of how politically sensitive it might be considered. This is not the case in other parts of the world, representing potential future partners in Global TA. How much of a problem this is, varies on how dependent on the policy system one finds TA to be. While some see TA as tightly interwoven to liberal democracy and its methodologies inspired by democratic values of inclusion and deliberation (Grunwald 2018; Hennen & Nierling 2018 in press) some others believe that even illiberal systems can be fertile grounds for such processes (e.g. Wong 2016). Whether one can achieve true independence of opinion or true public engagement in both systems, is a matter of debate. But it is important to remind ourselves that 'different' is a necessary precondition for negotiation and compromise, and a global approach will certainly require both in great supply.

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Technology Assessment in Australia

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1 Science and Technology Policy Structures and Technology Assessment

Technology Assessment (TA) is recognised around the world as a way of analysing and evaluating the impacts of new and existing science and technologies (Schot & Rip 1997; Brom et al. 2015). However, the term itself is not widely used in the Australian context nor is there a recognised practice of TA. Despite this, in Australia there is clear recognition that scientific research and innovation are key drivers for long-term productivity and economic growth (ISA 2016). Historically, Australia has embraced technological solutions to enhance the production and efficiency of its primary industries and resource sectors. As a nation, researchers here are exploring new frontier science in areas such as advanced manufacturing, cyber security and medical research, and are working hard to find solutions for transitioning to a sustainable energy future. Science and technology sit squarely at the heart of Australia's future.

The aim of this chapter is to describe the science and technology priorities and policy structures in Australia and determine whether TA is reflected in those existing structures. It begins with an overview of Australia's geography and its social, cultural and democratic systems. This is followed by a discussion of underlying national values and how these values are reflected in responses to science and technology. Building on this discussion, a selection of cases that illustrate how technologies have been introduced to Australia with a particular focus on the responses of the public are explored. The initial two cases examine unsuccessful attempts to introduce the use of recycled water and wind energy technologies in Australia. Subsequently a more recent case study that used TA processes of extensive and structured public engagement with respect to the nuclear fuel cycle in Australia is examined. Finally, conclusions on the role of TA in Australia and its relationship to a range of existing assessment processes are presented. The chapter demonstrates that Australia lacks any one national agency or institution responsible for TA. Therefore, assessments of technology may be accepted or rejected based on a range of national, state and even local government decision-making processes. While these processes may be formal and legislatively supported, they are often influenced by political pressure and public perceptions of a technology's benefits and risks.

1.1 Australia's Social and Political Context

Australia is a large island continent located in the Oceania region of the Southern Hemisphere. It is the sixth largest country in the world by land area (at 7.692 million km^2) and recognised for its geographic isolation, extensive national borders, limited supply of arable land, high levels of coastal urbanisation, and a heavy reliance on natural resources (Williamson et al. 2015). Sixty seven percent (67%) of Australians live in large coastal centres along the eastern seaboard (ABS 2017b). For its size, Australia hosts a relatively small population of 24.7 million residents (ABS 2017a). While the history of Indigenous settlement in Australia is known to stretch back some 65,000 years (Clarkson et al. 2017), Indigenous Australians comprise only 2.8% of Australia's current population (ABS 2017d). Today the Australian population is considered highly multicultural with 28.5% of the estimated resident population born overseas (ABS 2017c).

To understand contemporary Australia, its society, culture and values it is important to have a brief background in how the separate British colonies (now the states) formed a Commonwealth (in 1901) and how the idiosyncratic nature of that unification shaped the role of the Federal Government, States and Territories. Within Australia, there are six States and two Territories each with their own Parliaments and at the regional level there are multiple local government areas. Politically, the Australian parliamentary system is a constitutional monarchy with national elections held every three years. These arrangements reflect aspects of the British Westminster system which comprise the Monarch, the Senate and the House of Representatives. The Australian Constitution, passed as an Act of British Parliament in 1900, defines the formal rules by which Australia is governed.

The power of the Australian Parliament is limited under the Constitution to specific areas including: defence; external affairs; interstate and international trade; taxation; foreign, trading and financial corporations; marriage and divorce; immigration; bankruptcy; and interstate industrial conciliation and arbitration (Parliamentary Education Office 2010). The specific powers of the Commonwealth government reflect the key social, political and economic preoccupations of the late 19th century to ensure free trade and movement of people within the new nation. In many ways, these specific powers do not reflect many of the areas of political, economic and social concerns of the 21st century. Therefore, a number of important subjects that are not explicitly included such as: education; environment; criminal law and roads were considered residual powers and were left to the States and Territories. However, the Commonwealth has considerably increased its powers through ongoing interpretations of the Constitution by the High Court. The environment, which was absent from any national interest until the 1960s, is one area in particular where the Commonwealth has vastly increased its power through the signing of international agreements and treaties, which trigger its external affairs powers (Section 51 xxix) (Edmonds 1990; Parliamentary Education Office, 2010). However, unless this power is invoked, each State or Territory is responsible for assessing and approving the majority of development, including the use of technologies, through existing planning and approval mechanisms such as Environmental Impact Assessments, Social Impact Assessments and Development Applications.

It is worth noting that this State-level responsibility can give rise to diverse responses to technologies across Australia. For example, while the development of unconventional gas resources such as Coal Seam Gas (CSG) require federal-level approval where they will have a significant impact on water resources, CSG development tends to primarily be the responsibility of State Governments. The current status of CSG development across Australia, which has polarised some communities (Lacey & Lamont 2014), has seen full or partial moratoriums on CSG development and the use of technologies such as hydraulic fracturing in various states. These differences exacerbate tensions around the use and application of such science and technologies and reflect the political environment of the various States rather than an integrated and national system of technology assessment.

1.2 National-Level Decision-Making Frameworks

While the states may adopt different approaches, at the national level, the Australian Government plays a key role in funding science and technology research. Predominantly, the major investment occurs in areas such as environmental management, defence and health services, which are considered unlikely to be taken up at scale by other actors in the innovation system. In the *National Science Statement* (Australian Government 2017a), three key roles for government are defined which include: providing funding and other key resourcing; participating in science by producing, using and sharing data; and enabling science by setting institutional arrangements that support effective interactions with business and the Australian community for national benefit.

At the national scale, the key components of the overall science and innovation governance system includes a broad range of stakeholders, who are both directly and indirectly related to the flow and use of research funding (see Figure 1).

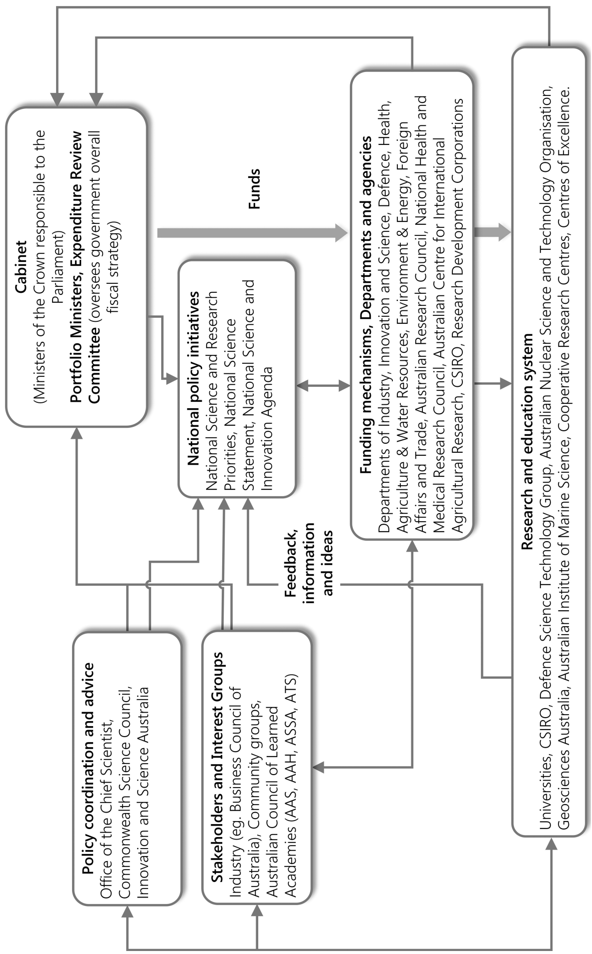

Figure 1: Overview of Australia's research and innovation system (adapted from ERAWATCH 2012)

The functions and stakeholders directly related to how research funds are allocated and used include:

High Level Decision-Making
The Cabinet, comprised of the Ministers of the Crown directly responsible to the Parliament, the Portfolio Ministers overseeing relevant areas of responsibility, and the Expenditure Review Committee, which oversees the national fiscal strategy, are collectively responsible for high level decision-making.

Funding Mechanisms including Federal Departments and Agencies
Responsibility for different aspects of development and implementation of science and technology policy is then distributed across government and managed where it is most relevant. There is a strong focus on whole-of-government coordination and the use of national advisory bodies for providing specific advice on policy development and institutional arrangements. At this level, there are a number of Departments including the Department of Industry, Innovation and Science (DoIIS[1]), which leads Australia's whole-of-government science and innovation agenda. DoIIS coordinates with a range of other departments with specialised areas of focus and may fund specific research in these areas including Defence[2], Health[3], Agriculture & Water Resources[4], Environment & Energy[5], and Foreign Affairs & Trade[6] among others. These departments are also variously responsible for national science and research agencies including the Commonwealth Scientific & Industrial Research Organisation (CSIRO[7]), Australian Centre for International Agricultural Research

1 https://industry.gov.au/
2 http://www.defence.gov.au/
3 http://www.health.gov.au/
4 http://www.agriculture.gov.au/
5 https://www.environment.gov.au/
6 http://dfat.gov.au/
7 https://www.csiro.au/

(ACIAR[8]), the Research & Development Corporations (which fund industry specific research[9]), for example.

Alongside this, the two key research funding bodies are the Australian Research Council (ARC[10]) and the National Health and Medical Research Council (NHMRC[11]). The ARC's mission is to "deliver policy and programs that advance Australian research and innovation for the benefit of the community". The NHMRC was previously managed by the government's health portfolio but has been a self-governing statutory authority since 2007. The NHMRC develops and maintains health standards in Australia and is the peak funding body for medical research.

Research implementation

Implementing the funding and conducting scientific research are a range of organisations that include universities, the CSIRO (which both funds and delivers research), and a series of national agencies with dedicated areas of focus including the Defence Science and Technology (DST[12]) Group providing advice on technology solutions for national security, the Australian Nuclear Science and Technology Organisation (ANSTO[13]), Geoscience Australia[14], and the Australian Institute of Marine Science[15]. In addition, there are two significant collaborative research investments that bring together universities, publicly funded research organisations, other research bodies, governments and businesses in Australia and overseas to examine areas of new science and where Australia has potential to build a competitive advantage. They are

8 http://aciar.gov.au/
9 http://www.agriculture.gov.au/ag-farm-food/innovation/research_and_development_corporations_and_companies
10 http://www.arc.gov.au/
11 https://www.nhmrc.gov.au/
12 https://www.dst.defence.gov.au/
13 http://www.ansto.gov.au/
14 http://www.ga.gov.au/
15 https://www.aims.gov.au/

the ARC Centres of Excellence[16] and the Co-operative Research Centres (CRC[17]) program.

Apart from these actors who are directly involved in the funding channels to support the implementation of scientific research and development in Australia, there are also a range of key stakeholders and initiatives that influence the system including:

Policy coordination & advice

Mainly overseen by the Office of the Chief Scientist[18], which is responsible for providing high-level independent advice to the Prime Minister, and other Ministers, on matters relating to science, technology and innovation. This Office also coordinates science policy issues across government portfolios. Additionally, there are two major government advisory bodies for science and technology policy. The first, the *Commonwealth Science Council* (CSC[19]), hosted by the Office of the Chief Scientist which connects government, business and academic leaders to advice on how science, research and innovation can contribute to productivity, health and well-being outcomes. It also advises on priorities for future areas of science and technology policy development. The second is *Innovation and Science Australia* (ISA[20]), which is an independent statutory authority responsible for providing strategic whole-of-government advice on science, technology and innovation.

National policy initiatives

The above advisory functions play a key role in the development of national

[16] http://www.arc.gov.au/arc-centres-excellence

[17] https://www.business.gov.au/assistance/cooperative-research-centres-programme

[18] http://www.chiefscientist.gov.au/

[19] http://www.chiefscientist.gov.au/commonwealth-science-council/

[20] https://www.innovation.gov.au/page/innovation-and-science-australia ISA recently audited Australia's science and innovation system and produced the 2030 Strategic Plan (2017) which contains a series of recommendations to government: https://industry.gov.au/Innovation-and-Science-Australia/Australia-2030/Pages/default.aspx

science priorities and policy initiatives including the *National Science Statement* and the *National Science and Innovation Agenda*[21], among others. These will be discussed further in Section 2.

Key stakeholders and interest groups

Beyond the government driven agenda for research in Australia, there are also a range of key stakeholders and other interests groups which include the Australian Council of Learned Academies (ACOLA[22]), an independent, not-for-profit organisation comprised of: the Australian Academy of the Humanities (AAH); the Australian Academy of Science (AAS); the Academy of Social Sciences in Australia (ASSA); and the Australian Academy of Technology, Science and Engineering (ATSE). ACOLA predominantly functions as a form of Parliamentary TA, receiving funds from the Office of the Chief Scientist to undertake horizon scanning activities. These activities are led by esteemed representatives from each of the Academies to ensure an interdisciplinary approach to an identified challenge. Three recent horizon scanning studies on energy storage, precision medicine and synthetic biology, are used to provide expert advice to government.

Beyond the domain of science and technology research, there are also a range of industry and public interests to be considered. While industry interests are directly addressed through a variety of research areas and funding models, and organisations such as the Business Council of Australia[23], the role and interests of publics are harder to identify within the research governance system. Section 3 highlights how citizen and community views are expressed and often exert a powerful influence in matters of TA in Australia. However, first it is useful to examine Australia's science and technology priorities.

21 https://www.innovation.gov.au/
22 https://acola.org.au/wp/
23 http://www.bca.com.au/

2 Science and Technology Priorities and Values

While science and technology priorities change over time, the Australian Government of today has a clear statement that "Australia depends on science and research to increase productivity, achieve sustainable economic growth, create jobs, and improve national well-being" (Australian Government 2017b). The current nine national science and research priorities outlined by the federal government in the *National Science Statement* (Australian Government 2017a) are:

- Advanced Manufacturing
- Cyber Security
- Energy
- Environmental Change
- Food
- Health
- Resources
- Soil & Water
- Transport.

These priorities were developed through a consultative process[24] involving leaders from industry, research and government. This helps ensure the Australian Government is supporting science and research activities focused on addressing the most critical challenges facing the nation (Australian Research Council 2015). The national science and research priorities also assist the Australian Research Council (ARC) to assess how funding will be directed.

[24] After presenting the priorities to the inaugural meeting of the Commonwealth Science Council in November 2014, the Chief Scientist ran a series of workshops with working groups for each priority area. Industry representatives had a critical role in identifying the practical research challenges underpinning the science priorities. The identified challenges were then further refined through targeted consultations with industry, State and Territory Chief Scientists, the higher education and research sectors, the CSIRO and other government departments. The Commonwealth Science Council recommended the priorities and practical research challenges to the Australian Government in April 2015.

Through a competitive process, research proposals are evaluated and funded based on how effectively they align with the key research priority areas. This ensures Australia's finite research resources are directed towards the most critical challenges.

The *National Science Statement* further emphasises that strategic investment in science and research will be a new source of growth, high-wage jobs and will drive future economic prosperity for Australia. An annual assessment conducted by the Office of the Chief Economist quantifies the nature of the economic benefits of science to the nation (Office of the Chief Economist 2017). This assessment is undertaken against a set of innovation indicators including measures of entrepreneurship, international engagement, business collaboration, education and skills base, and investment in research[25]. In economic terms, Australia's assessment of the benefits of science and technology is rigorous and transparent. The *National Science Statement* also points to the importance of science and technology driving advances in knowledge and improvements in living standards. This is characterised broadly in terms of contributing to the well-being of Australians through improving health outcomes, maintaining our environmental quality, and resolving complex social challenges. Here the impact assessment approaches are less well formulated and applied. Societal benefit is recognised as a critically important outcome of science and technology investment. But, how that might be realised and how such benefits address challenges of equity and opportunity in the distribution of those benefits remains unclear (Russell et al. 2011). This was a weakness identified in a review of the Australian innovation system (ISA 2016), which identified that Australia needs to improve its translation of publicly funded research to commercial outcomes to capture greater social value from scientific research. This has become a greater focus of the Australian Government with all bodies receiving funds needing to identify the potential and achieved impact of their research. Although priorities for research and science are set at a national level, and informed by consultation, the extent to which these

[25] Indicators are available at: https://industry.gov.au/Office-of-the-Chief-Economist/Publications/AustralianInnovationSystemReport2017/index.html

reflect broader community attitudes to science, technology and innovation is difficult to gauge.

In terms of better understanding the views of the public, there have been several major studies of Australian attitudes to science and technology over recent years. Frequently, when the results of these studies are considered together, they are found to be contradictory and highlight how complex public attitudes to science and technology are (Cormick 2014). For example, the findings of an Australian National University (ANU) study undertaken in 2010 claimed that Australian were more interested in science than sport (ANU 2010). But studies conducted by the Victorian State Government in 2007 and 2011 documented far less interest in, and engagement with, science among the public. Among these studies, a recent 2016 survey of Australian beliefs and attitudes towards science undertaken by the ANU aimed to develop insights into the level of overall engagement with science in the Australian population, and to measure their overall awareness of the benefits of science to society (Lamberts 2016). Key findings from this survey identified that the majority of Australians were regularly engaged in some kind of science-related conversation and over 90% used technology at least a few times a week. Australians also rated the top three professions contributing to the well-being of society as scientists (80.9%), followed by doctors (80.5%) and farmers (78.5%).

The 2016 ANU study highlights a range of positive results with respect to public attitudes to science and technology. However, this study also found that almost half of their respondents expressed the view that science made our lives change too quickly (Lamberts 2016). Agreement with this sentiment in particular has been interrogated by the CSIRO and identified as a key indicator of Australian society "being less engaged with science and technology and more likely to view it with suspicion and concern" (Cormick 2014: 2). This highlights that simply examining the levels of scientific knowledge or engagement with science among the public may not explain how and why their attitudes towards science and technology are formed. For example, the 2016 study by ANU found evidence of a broad range of views on issues such as

Genetically Modified (GM) foods, nuclear energy and bioengineering (Lamberts 2016). Frequently values play a key role in attitude formation (Wynne 1992; Mohr et al. 2007; Nisbet & Goidel 2007). Similarly, Cormick (2014) has argued that a closer examination of values can help explain how people can hold seemingly contradictory attitudes toward science (i.e. people with strong values about preserving nature may accept climate science but reject GM crops). Thus, responses to science and technology, whether this relates to debates about childhood vaccination, stem cell research or autonomous vehicles and so on, are often deeply connected to our values.

2.1 Fundamental Australian Values

In terms of providing an understanding of the national values that shape responses to science and technology, Australia's colonial past, the early policies introduced after federation that sought to restrict immigration to Europeans and were later dismantled from 1949 through to 1973, along with the more recent development of a multicultural national identity have directly influenced how Australian social and cultural values have formed and changed over time. There have been frequent periods when questions are raised in the public arena about what constitutes 'Australian' values and identity. From the post-World War II decades and through until the 1970s, the preferential immigration to Western Europeans, and particularly those from the United Kingdom did lead to a relatively strong and persistent set of characteristics being considered as the stereotypical national identity of the non-indigenous people of Australia. These identities have been referred to as myths and frequently include the 'typical Australian' being described as egalitarian, anti-authoritarian, practical or laconic (Moran 2011) However, there have been many critiques of these identities dating back to the 1960s (Horne 1964; McGregor 1966). What is clear is that modern Australia is diverse in values and that the old stereotypes do not well represent contemporary attitudes. The notion of Australian values remains contested and evolving, but despite this the majority of our fundamental social values tend to align with those that characterise most Western liberal democracies. These broadly include freedom, equality, and justice. To this list, we add sustainability.

2.1.1 Freedom

As in many liberal Western democracies, freedom is a cornerstone of Australian society, and the concept of freedom is closely connected to rights, particularly the rights of individuals to enjoy these freedoms as citizens (Schroeder & Rerimassie 2015). Within the laws and requirements of our governing institutions all citizens are entitled to a series of fundamentals freedoms that include: the freedom to speak openly; the freedom of association; the freedom to worship in their faith of choice; the freedom to marry who they choose; and the right to move freely throughout Australia without restriction.

These freedoms underpin Australia's democracy, and mean that all Australians have the opportunity to participate in how the country is governed through processes such as voting, providing input to elected representatives, or becoming involved in political rallies or citizen movements. This creates a series of individual rights and freedoms that are reflected as rights that also govern the national population as a collective. For example, the fundamental freedom for Australians to marry who they choose has recently been contested in Australia through the need to acknowledge the rights of gay and lesbian people to marry. This resulted in a national plebiscite which ended in a majority 'yes' vote, which changed the laws in the Australian Parliament and created a national debate on the freedom and equality of contemporary Australian society.

A science and technology priority that is particularly focused on protecting these freedoms is cyber security. Cyber security critically underpins Australia's knowledge economy and there is a focus on protecting our cyber infrastructure from malicious attacks and non-malicious events such as natural disasters, equipment failures and so on. The *National Science Statement* recognises the need to understand the scale of cyber security challenges facing Australia, including the social factors that influence individual, organisation and national attitudes (Australian Government 2017a). This has been accompanied by increased scrutiny of the use of data and open access to data in Australia to enhance societal, environmental and economic benefit along with managing associated privacy and security concerns (i.e. balancing collective benefit with individual freedoms) (Productivity Commission 2017).

2.1.2 Equality

The concepts of equality and even egalitarianism remain contested in social and political theory (Dworkin 2000; Arneson 2013) but they are closely coupled with ideas of justice and morality in Western liberal democracies. Under Australian law, all citizens must be treated equally which means that no one should ever be treated differently because of their race, ethnicity or country of origin; due to age, gender, marital status or disability; or because of religious or political belief. Equality of opportunity in Australia is supported by a series of laws such as the *Racial Discrimination Act 1975,* the *Sex Discrimination Act 1984,* the *Disability Discrimination Act 1992* and the *Age Discrimination Act 2004.* However, while it is straightforward to recognise equality through these legal mechanisms, it can be challenging to navigate how equality is operationalised and realised in political terms (Schroeder & Rerimassie 2015). For example, should equality in Australian society be realised in terms of equality of welfare, resources, opportunities or capabilities (Daniels 1990; Nussbaum 2011)?

This idea of equality is frequently expressed colloquially in Australia as everyone being entitled to receiving 'a fair go'. This means that every citizen has the opportunity to prosper yet it is also recognises that life circumstances may mean that some citizens will require more support than others. This is reflected in the existence of a welfare system to provide access to basic resources. One example of this is Australia's publicly funded universal healthcare system, Medicare. This system is the largest primary funder of healthcare in Australia and supports access to basic health services for citizens. This commitment to equality of access to healthcare underpins the national science and technology priority focused on health where impact needs to be realised at both individual and population scales. Key challenges have been identified in relation to developing better models of healthcare that reduce disparities of disadvantage, increase health care access for vulnerable groups, and ensure better health outcomes for regional and Indigenous communities (Australian Government 2017a).

2.1.3 Justice

Building on the principles of freedom and equality, justice sits at the heart of all forms of social interaction. While Rawls (1999) regards justice as the first virtue of social institutions, his focus has been regarded as somewhat narrow in its application to the fair distribution of economic goods and resources (Anderson 1999; Nussbaum 2003). Thus, while the broad theme of "justice as fairness" (Rawls 1999: 3) links the importance of preserving basic liberties and fair opportunities within society (Gutmann & Thompson 1996), there is an effort to move beyond the mere application of distributive justice in terms of the distribution of particular goods, to examine how it might also preserve and enhance those most critical social opportunities. The focus here is not merely on the *outcomes of justice* (i.e. how such goods or opportunities are shared); rather it also includes components of interactive and procedural justice which capture the importance of the *process of justice*.

In this way, justice underpins the social interactions and processes between key parts of our society and the structure of the institutions that govern decision-making in this domain. This specifically addresses questions about where risks and benefits flow from the application of science and technology, how diverse perspectives will be represented in decision-making processes, and who will be responsible for ensuring equitable outcomes as a result of such decisions. Current debates about the mining and extractives sectors have highlighted that how citizens perceive justice and fairness is a predictor of how willing they are to accept these industries at local and national scales (Moffat et al. 2018). Given energy is a national science priority, Australia is grappling with its abundant energy resources and the need to establish a sustainable energy future that will progressively reduce carbon emissions and be affordable and reliable for consumers (Finkel et al. 2017). Such challenges around the world have given rise to the new agenda of energy justice which applies the principle of justice to energy policy, energy production and systems, energy consumption, energy activism, energy security and climate change (Jenkins et al. 2016).

2.1.4 Sustainability

While the previous values relate more to the social aspects of life in Australia, sustainability is a value that speaks more directly to environmental values. For this reason, it is a value that may have the capacity to draw together the values of both ancient and modern societies. This includes the many thousands of years of Indigenous culture that reflects a strong connection to land. This value speaks directly to the need for modern Australia to carefully manage and use its finite resources in a sustainable way. Both primary industries and resource development sectors have been integral to Australia's development and growing economy but understanding sustainable use of resources – be it water, energy or food – is at the heart of many challenges. These challenges are not unique to Australia but given the highly variable climate and high dependency on agricultural areas, sustainable use of all Australia's resources is required to support current and future citizens.

This focus on sustainability is strongly reflected in a number of the national priorities including soil and water, environmental change and food. It is established that Australia's soil, vegetation, biodiversity, water and marine resources are "strategic assets that should be highly valued and strategically managed" (Australian Government 2017a). This is currently reflected in major research initiatives that are focused on critical assets such as the Great Barrier Reef, Northern Australia, key agricultural regions, major aquifers and urban catchments. However, the principle of sustainability itself is also debated and the ways in which we might intervene in natural systems give rise to a range of values-based responses to science and technology (Cormick 2014).

3 TA State-Of-Art: Methodologies and Impact

While it has already been established that Australia lacks any national agency or institution responsible for TA, it is useful to examine a range of recent processes and their influence on the uptake (or not) of different technologies in Australia. This is relevant because in Australia technologies are more likely to be assessed, accepted or rejected based on a range of State and even local government decision-making processes that are formal and legislatively supported (e.g. Environmental Impact Assessments, Social Impact Assessments, Development Applications). Very often, these assessments are rarely about the technologies themselves but rather a new or changed land use, permission to develop resources or the introduction of a new industry. This section briefly examines three cases of TA-like processes in relation to recycled water, wind energy and the nuclear fuel cycle. Each took place in different parts of Australia but what is apparent in all cases is that the role of public engagement in response to where or how the technologies were going to be implemented exerted significant influence over the outcomes of these processes.

3.1 Technology Rejection: The Role of Public Engagement

First, two failed attempts to introduce recycled water in Queensland and wind energy in Tasmania are examined. These two cases are introduced to highlight the often localised nature of TA-like processes in Australia (both were overseen by local governments) and with a particular focus on the role of public engagement (both used a vote to determine the outcome). As Hennen et al. (2004) point out, any discussion about TA and its relationship to policy making will invariably examine processes of decision-making, and the nature and content of political and social debate. It has long been recognised that a technical assessment that ignores political and social contexts is likely to be doomed to failure. But these cases illustrate involvement of the public does not always lead to success.

3.1.1 Recycled Water for Toowoomba, Queensland

The highly volatile nature of Australia's climate is well known. Prolonged droughts are a frequent and recurring experience that often devastate Australia's agricultural areas. However, from 2001 to 2007 a significant and extended period of drought affected most of eastern Australia and began to threaten the security of urban water supplies in Melbourne, Sydney and Brisbane (the major capital cites on the east coast) as well as many regional cities. While rural populations frequently experience the impacts of drought in Australia, it was rare for these impacts to be felt so acutely in the larger urban centres. In response to this crisis, Toowoomba (a regional city in southern Queensland with approximately 100,000 residents) began to explore a range of options to secure and supplement water supplies. Given the city was already under severe water use restrictions by 2004, the option of recycling water, treating it and then returning it to the city's reservoir was proposed. The option was both technically feasible and sought to support a sustainable solution to the management of water resources. However, this was also the first time that recycled water for potable use had been seriously considered in Australia.

The proposal triggered a campaign on the application of the technology. Intense public debate and outrage against the proposal emerged that lasted for almost two years (Hurlimann & Dolnicar 2010). Proponents tried to 'educate' the public with scientific facts using a range of media, while those opposed launched a fear-based campaign that told residents they would be forced to drink 'poo-water'. Those opposed focused messages around issues of fear and risk in relation to health and environment but also tapped into perceptions of injustice (i.e. those in Toowoomba would drink the recycled water while those in the nearby capital city would not have to). The issue was put to a referendum. While polls taken a year before the final vote suggested majority support of recycled water (60%), at the final vote in 2006, almost two thirds of the city voted against recycled water. This case highlights a seemingly democratic engagement in relation to a specific technology (i.e. citizens were asked to vote) but this disconnect between scientific and social assessment of the technology paved the way for its failure.

3.1.2 Wind Energy for King Island, Tasmania

Similarly, a citizen vote was also problematic in an assessment of a proposed wind farm on a small island off the coast of Tasmania (Colvin et al. under review). While sustainable energy options such as wind energy tend to garner broad public support, they frequently generate localised opposition (Colvin et al. 2016). In this case, a large-scale wind farm was proposed in 2013. The AUD $2 billion proposal outlined plans for a 600MW wind turbine development to produce energy for export to mainland Australia via a proposed undersea cable. In this case, the company developing the wind farm sought to engage with the community for a pre-feasibility study with the rationale that early engagement would provide a range of opportunities for dialogue, collaboration and shared decision-making. However, in this case, community engagement in a pre-feasibility assessment of the project polarised the community, and strained local relationships and institutions. A vote was held to assess community support for the proposal. In the lead up to this vote, the support and opposition campaigns divided the small community. The result which showed 58.7% in favour of the project was itself polarising. This was because an informal benchmark of support had been claimed to be 60% at a community meeting in the lead up to the vote. The validity of the voting process was questioned. Ultimately the proposal did not pass its pre-feasibility assessment and left a legacy of community division and conflict in its wake.

Both of these cases demonstrate local responses to particular technologies in Australia and highlight how public responses can override any formal or legal processes for approving the use of technologies in these contexts. While these localised cases highlight rejection of technologies, their flaws seemed to relate specifically to the lack of deliberation built into the public engagement mechanisms.

3.2 Public Engagement with the Nuclear Fuel Cycle

In terms of structured and deliberative processes for TA in Australia, an example is the recent assessment of the future of the nuclear fuel cycle in South Australia (SA). While still not a national scale process, it illustrates a range of TA activities and demonstrates how the results were translated into decision-making at the state-level, with a particular focus on formalising a range of processes of public engagement. In this case, the SA Government conducted a Royal Commission to explore issues and opportunities associated with the nuclear fuel cycle. The Royal Commission represented a form of Parliamentary TA, particularly with the aim of the activity being to provide advice to the Parliament on nuclear fuel cycle related technology, in relation to both public interest and political decision-making. The results showed that while nuclear power was not considered a viable option for Australia, radioactive waste reprocessing was identified as a potential future industry. Because the management of radioactive waste remains a contentious and unresolved technology around the world (Slovic 1993), the SA Government proposed they would consult with the SA public to decide whether to establish a reprocessing industry in the state.

South Australia is the fourth largest state, located in the southern central part of the country and characterised by some of the most arid and sparsely populated parts of the landscape (Figure 2). The majority of the 1.7 million South Australians (less than 8% of the national population) reside in the capital city of Adelaide. Historically, this state is the only one of the former British colonies to be freely settled as opposed to being established as a penal colony. It is also home to the Olympic Dam mine, which has the largest uranium deposit in the world, containing more than one third of the world's recoverable reserves of uranium and 70% of the Australian reserves. In recent years, SA has seen the loss of its significant car manufacturing sector, which has placed pressure on the State's employment and economic performance.

Figure 2: South Australia in the national context

With South Australia's economy undergoing a shift away from traditional industries such as manufacturing, the state government implemented a process to identify and explore new, high tech industries of the future (Government of South Australia 2017a). The first step was the formation of the Nuclear Fuel Cycle Royal Commission. The task of the Commission was to examine the practical, economic and ethical issues that would arise if South Australia was to extend into all aspects of the nuclear fuel cycle (i.e. mining, enrichment, energy, storage). In undertaking the examination of these issues, the Royal Commission consulted with 132 expert witness (including 41 international experts) over a period of 37 sitting days. The result was a report released in May 2016 that outlined 12 key recommendations (Nuclear Fuel Cycle Royal Commission 2016: 170).

Many of the 12 recommendations were targeted at institutional reform between the state and federal governments in relation to how aspects of the nuclear fuel cycle are approved and managed in Australia (i.e. there are currently strict limits on how uranium is handled and nuclear energy is prohibited in Australia as a result of a national referendum held in the 1960s). There were also a series of recommendations that targeted the need to improve baseline geophysical data and make it more accessible to a wider range of stakeholders. While the Commission deemed processing of radioactive waste and nuclear energy not immediately viable within the State, the report did recommend that the disposal of used nuclear fuel and intermediate level waste in a permanent geological disposal facility presented an opportunity that had potential to deliver significant inter-generational economic benefits to South Australians (Nuclear Fuel Cycle Royal Commission 2016). However, it was also recognised that attempts to develop nuclear industries around the world had been complex and that if any of the recommendations were to be fully considered by the SA Parliament, there would need to be full scale public consultation and engagement with the SA community.

This was the basis for the second step of the process, a comprehensive state-wide engagement program. The engagement program was structured and delivered in four stages from June to November 2016 and remains one of the most comprehensive state-wide engagement programs undertaken in Australia to date. The stages included:

Stage 1: Be informed
Over two weekends in June and July 2016, 50 randomly selected South Australians came together to form a citizens' jury. The jury worked together over 4 days to extract the key elements of the Royal Commission report they felt needed to be debated and discussed with the broader SA public. The process was facilitated by an independent organisation and jury members were given access to experts to provide them more information on the findings of the Royal Commission. A key output of the first citizens' jury was a summary document in simple language that highlighted the key considerations for the SA public.

Stage 2: Be involved

Following the citizens' jury, a state-wide engagement program commenced and included a range of opportunities for South Australians to engage in the conversation "Know Nuclear". This included online forums, social media and hosted community events across the state. A travelling community engagement roadshow visited more than 100 sites throughout the state, including 60 regional towns and 30 Aboriginal communities during an extensive three-month consultation period. Reports and fact sheets were produced in Aboriginal languages to ensure all South Australians had equal access to information as part of their engagement. This stage was designed to ensure the SA Government could hear key issues from all parts of the SA community.

Stage 3: Be clear

Following the state-wide engagement, the 50 original members of the first citizens' jury reconvened and were joined by an additional group of 250 randomly selected South Australians to form a second citizens' jury (i.e. with 300 citizen members). This second jury met over three weekends in October and November 2016 (i.e. 6 days) to deliberate on the following question: "*Under what circumstances, if any, could South Australia pursue the opportunity to store and dispose of nuclear waste from other countries?*" (Government of South Australia 2017b). This was Recommendation 11 from the Royal Commission Report. All jurors were required to review all of the community feedback from the previous state-wide engagement and were informed by more than 100 witnesses throughout the process[26]. Their findings were presented in a report to the SA Premier and was tabled in the SA Parliament.

Stage 4: South Australian Government's Response

The report from Citizens' Jury Two played a key role in informing the State Government's response to the Royal Commission Report. In November 2016, the SA government submitted its own response to the Royal Commission Re-

[26] Full details of the second citizens' jury are available at https://nuclear.yoursay.sa.gov.au/citizens-juries/citizens-jury-two

port supporting nine of the 12 original recommendations. The recommendation to pursue the disposal of used nuclear fuel and intermediate level waste in a permanent geological disposal facility as a future industry in South Australia was not fully endorsed but it was flagged for further investigation. See Table 1 for a summary of all 12 recommendations of the Royal Commission and the outcomes of the subsequent engagement program and parliamentary decision-making processed.

Table 1: Recommendations endorsed by South Australian Government and Citizens on Nuclear Fuel Cycle (Government of South Australia 2016)

	Recommendations	**Endorsed**
1.	Pursue the simplification of state and federal mining approval requirements for radioactive ores, to deliver a single assessment and approvals process	✓
2.	Further enhance the integration and public availability of pre-competitive geophysical data in South Australia	✓
3.	Undertake further geophysical surveys in priority areas, where mineral prospectivity is high and available data is limited	✓
4.	Commit to increased, long-term and counter-cyclical investment in programs such as the Plan for Accelerating Exploration (PACE) to encourage and support industry investment in the exploration of greenfield locations	✓
5.	Ensure the full costs of decommissioning and remediation with respect to radioactive ore mining projects are secured in advance from miners through associated guarantees	✓
6.	Remove at the state level, and pursue removal of at the federal level, existing prohibitions on the licensing of further processing activities, to enable commercial development of multilateral facilities as part of nuclear fuel leasing arrangements	X
7.	Promote and actively support commercialisation strategies for the increased and more efficient use of the cyclotron at the South Australian Health and Medical Research Institute (SAHMRI)	✓
8.	Pursue removal at the federal level of existing prohibitions on nuclear power generation to allow it to contribute to a low-carbon electricity system, if required	X

9.	Promote and collaborate on the development of a comprehensive national energy policy that enables all technologies, including nuclear, to contribute to a reliable, low-carbon electricity network at the lowest possible system cost	✓
10.	Collaborate with the Australian Government to commission expert monitoring and reporting on the commercialisation of new nuclear reactor designs that may offer economic value for nuclear power generation	✓
11.	Pursue the opportunity to establish used nuclear fuel and intermediate level waste storage and disposal facilities in South Australia consistent with the process and principles outlined in Chapter 10 of the [Royal Commission] report	**Support further investigation**
12.	Remove the legislative constraint in section 13 of the *Nuclear Waste Storage Facility (Prohibition) Act 2000* that would preclude an orderly, detailed and thorough analysis and discussion of the opportunity to establish such facilities in South Australia.	X

The overarching engagement program in the nuclear fuel cycle case is a clear example of Participatory TA in that it sought to systematically involve various actors in the engagement program. While the focus was on SA citizens, methods were developed to ensure that citizens who might ordinarily be excluded by geographical remoteness or not use English as their first language were included in the process[27]. The process also brought experts in contact with citizens to deliberate over the ethical, economic and societal aspects of exploring new industries within the nuclear fuel cycle for South Australia. These processes were then used to inform a second round of Parliamentary TA through the Premier's formal response to the Royal Commission. Although consideration of the nuclear fuel cycle in SA continues beyond this process, there is ample evidence to draw on in order to make an assessment of the current and future potential of TA in Australia.

[27] The Indigenous Engagement component by the South Australian won a 2017 International IAP2 Award: https://www.iap2.org.au/Awards/2017-Core-Values-Awards

3.3 Analysing the Presence of TA in Australia

The typology of TA impacts matrix developed by Hennen et al. (2004) and presented in the introduction chapter of this book outlines three impact dimensions: (1) raising knowledge; (2) forming attitudes/opinions; and (3) initialising actions. These three impact dimensions each have an issue dimension which can be further characterised by: (i) technological/scientific aspects; (ii) societal aspects; and (iii) policy aspects. In terms of how the nuclear fuel cycle case study rates against the typology of TA impacts (Hennen et al. 2004), there was evidence of activities in all three of the impact dimensions.

First, the act of 'raising knowledge' speaks directly to both the content generated and the participatory processes used to make various actors aware of new aspects of the issue under consideration. Raising knowledge was addressed comprehensively as the SA Government process aimed to examine the potential new industries associated with the nuclear fuel cycle. There was a focus on generating a robust scientific assessment of the technical options and making them visible for consideration by stakeholders. The materials generated were used in multiple engagements and presented as reports and fact sheets in various languages, via expert presenters visiting communities to talk to policy makers and citizens, and with physical models of different facilities to aid discussion of future possibilities. The extensive nature of the engagement processes and the data gathered from these engagements also helped to make the structure of existing conflicts transparent through social mapping. In terms of raising knowledge, policy analysis was also undertaken and a range of policy objectives were explored. For example, it was established early on that nuclear power was not an option but a reprocessing industry could be further explored through public engagement. Under this impact dimension, the SA case demonstrated activities that addressed scientific/technological aspects, societal aspects and policy aspects.

Second, in 'forming attitudes/opinions', the SA process demonstrated elements of agenda setting by actively stimulating public debate with the use of citizen juries to initially assess key elements requiring public debate and later to address a specific question about the importation, storage and reprocessing of radioactive waste. A number of policies were also evaluated as a result of this public debate (see recommendations in Table 1) and extensive state-wide engagement was perceived as democratic and fair. Under this impact dimension, the SA case clearly demonstrated activities that addressed scientific/technological and policy aspects. The use of the jury process may also represent a form of mediation as it created an environment, which encouraged a small group of citizens acting on behalf of their State to reflect on their own expectations while incorporating a range of other views.

Third, under 'initialising actions', there was evidence of reframing the debate when the Royal Commission was tasked with examining all practical, economic and ethical issues associated with extending into all aspects of the nuclear fuel cycle. This allowed the full extent of the nuclear fuel cycle to be explored in new ways in Australia in a highly transparent manner with input from a number of expert witnesses (Parliamentary TA). There was also evidence of a decision being taken when the SA Government responded to the recommendations of the Royal Commission and the feedback of the public engagement processes (see endorsements in Table 1). Under this impact dimension, the SA case demonstrated activities that addressed scientific/technological aspects and policy aspects.

The SA process was innovative in its approach and has been shown to demonstrate some best practice TA approaches. It also usefully highlights how a large-scale, structured public engagement process that was deliberative and democratic could be used effectively to inform a State Government decision-making process in Australia with the results reliably represented the combination of scientific, societal and policy aspects of the issue. However, this is far from being a typical process in the Australian context. While there are numerous public debates on matters of science and technology in Australia, very few of these debates are formally structured and hosted in such a way as to inform decision-making processes and outcomes in the way we have described in relation the nuclear fuel cycle case. Rather, participation has tended to occur around localised issues without an overarching approach to structuring the engagement, which has frequently served to polarise views on contentious issues as described briefly in Sections 3.1.1 and 3.1.2.

A review of TA in Australia, undertaken in 2011, found that while Australia had no central agency that coordinated TA functions, there was clear evidence of a range of TA-like activities being undertaken in the form of reviews and inquiries. However, they tended to happen in an uncoordinated or *ad hoc* way (Russell et al. 2011). At the time of this previous review, examples of such TA activities at the national-scale included: the first and only consensus conference undertaken in Australian in 1999 on gene technology in the food chain; the joint Australian Law Reform Commission and Australian Health Ethics Committee inquiry on the use and protection of genetic information which ran from 2001-2003; the Lockhart Review on human cloning and embryo research in 2005; and a federal Uranium Mining, Processing and Nuclear Energy Review to examine uranium mining and the potential for nuclear energy in 2006. The short timelines of both the Lockhart Review and the Uranium Review meant that no community consultation was undertaken suggesting that some TA processes are structured around public engagement methods while others do not resource it at all.

Again in 2018, we find that TA processes remain *ad hoc* and disconnected, or implicitly dealt with through existing formal and legislative process (i.e. often not focused on technology *per se*). There is a need for TA to be more systematic and inclusive in how it is conducted in Australia but also that such processes are considered trustworthy and influential (Russell et al. 2011). But there also remains a question as to how these TA processes will be integrated with existing assessment processes for new land uses and industries that are implemented at more localised levels across Australia, which may give rise to differential responses to technologies in the landscape. Can there be an integrated national system of TA in Australia?

4 National Perspectives for a Global TA

In Australia, there is a clear commitment to finding science and technology solutions for complex challenges. When thinking about the role of TA in Australia, most efforts focus on innovation as a driver of economic prosperity. Social well-being and national benefit are frequently cited as key drivers for science and technology development but it is less clear how this value is assessed and agreed upon. Although with the emerging focus on impact agenda it is likely that more of these outcomes will be monitored and assessed. In this chapter case study examples have highlighted that technologies themselves are frequently not at the heart of public debate in Australia. Rather, public debate is frequently driven by the capacity of these technologies to influence land use and/or social change. Similarly, how trade-offs are managed in resolving complex national challenges also remains unclear.

It would appear that the current status of TA in Australia continues to be undertaken in an *ad hoc* way (per Russell et al. 2011) and perhaps technologies are most likely to be evaluated when:

- Research is funded nationally or by industry (but the assessment tends to happen implicitly in the merits and/or ranking of the research based on the likely impact or benefit of the research activity and not the technology being applied).
- In conjunction with (but not necessarily explicitly) during development approval processes at State and Local Government levels. In some instances, these approvals may trigger a national power or legislative process.
- As part of a political process, which may be exacerbated by election cycles, and driven by political interests and public perceptions of risk in relation to certain issues. For example, the local example of recycled water in Toowoomba, the variable responses to CSG development and the use of hydraulic fracturing in the different states of Australia, and the ongoing and recurring national debate on nuclear energy and the storage of radioactive waste in Australia.

- There are identified potential risks to health, safety and environment, which can also apply to the importation of goods to Australia and the export of certain goods/materials.

The selected examples in this chapter also highlight that levels of engagement and participation are often highly variable across Australia (i.e. not often formalised or well-structured in terms of developing inputs transparently for decision-making), unevenly resourced, rarely focused on technologies themselves, and often driven by local and state formal and legal process (EIAs, SIAs, Development Applications etc.). New modes of more systematically engaging citizens (and other stakeholder input) and incorporating a stronger focus on Constructive TA as a matter of practice in Australia are required.

At the outset of the chapter, it was stated that science and technology sit squarely at the heart of Australia's future. There are clear lessons that can be drawn from existing models of TA as they are applied in Europe for the Australian context. This includes developing forms of assessment that support existing legal and regulatory frameworks with a view to providing mechanisms for more meaningful and robust deliberation of the ethical aspects of science and technology. Potentially, the greatest contribution TA could make in Australia is in providing the formal approaches and methods that engage publics and integrate this form of engagement with other methods of assessment in the consideration of the societal impacts of science and technologies (Hennen & Nierling 2014; Khanna 2017). The SA case highlights how a well-resourced and structured process that actively sought to engage over time and in diverse ways created a meaningful debate about the nuclear fuel cycle. All parties were not required to reach consensus and there was room for diverse views but there was a robust process in making engagement transparent, including in how the results of the engagement were used by the SA Government.

While the geographic size and small population of Australia can make this intensity of engagement prohibitive in terms of resourcing, creating an environment of meaningful deliberation on technologies would be of significant value. There are clear examples of Parliamentary TA and Participatory TA that could be extended in Australia. One area that would be beneficial to further explore is where and how Constructive TA might be incorporated in these processes to focus and enrich the discussion of technologies and their application. The experiences reported here suggest that consideration of technologies remains implicit and often peripheral to any formal assessment processes.

In terms of engaging in TA at a global scale, global governance models that enhance international cooperation but allow democratic freedoms to be maintained (i.e. through limited enforcement) may be instructive. However, given Australia's relatively limited experience of and engagement with TA in comparison to Western Europe and the United States, targeted cooperation on identified global issues or challenges would provide a more useful entry point for engagement, partnership and knowledge exchange at the global scale. There is still a need to build capacity to undertake TA processes at the national scale in Australia. However, this could be aided by existing and emerging strategic international collaborations on significant global challenges. For example, since 2014, the Australian and German Governments have been in regular dialogue with a view to building closer ties and exchanging experience and best practice on long-term energy strategy in both countries. This includes transferring lessons from the German *Energiewende* to help in accelerating change towards zero-carbon energy systems (Vivoda 2017). In a similar vein, the recent announcement of the Australian Government's Reef Restoration and Adaptation Program (AIMS 2018) is aimed at both restoring the Great Barrier Reef and developing technologies that can be applied to reefs around the world. In many ways, the structure of global research communities that transcend borders and national politics to focus on critical issues and enable knowledge transfer may provide the most useful model for developing a global TA that can bring multiple national perspectives to shared global challenges.

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Technology Assessment in China

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1 Science and Technology Policy Structures and Technology Assessment

The People's Republic of China is the largest populated country in the world, with around 1.4 billion people[1] and is located in East Asia. The capital is Beijing, the largest city is Shanghai. China is a unitary republic and is governed by the Communist Party of China in 22 provinces, five autonomous regions, four municipalities and special administrative regions (Hong Kong and Macau). Economic reforms in the late 1970s resulted in rapid economic growth, China is the second largest economy by nominal GDP (an estimated $11.938 trillion in 2017) and the largest worldwide by purchasing power parity ($23.122 trillion).[2] This has led to the development of a middle-class of about 300 million and to China having the world's second highest number of billionaires[3]. Since 2010 94% of the Chinese population over 15 years is literate, as a comparison in 1949 only 20% of the population could read[4]. In connection with these economic strides is the development of science and technology. In recent years

[1] https://esa.un.org/unpd/wpp/DataQuery/

[2] http://www.imf.org/external/pubs/ft/weo/2017/02/weo-data/weorept.aspx?pr.x=89&pr.y=14&sy=2016&ey=2018&scsm=1&ssd=1&sort=country&ds=.&br=1&c=924&s=NGDPD%2CPPPGDP%2CNGDPDPC%2CPPPPC&grp=0&a=

[3] https://en.wikipedia.org/wiki/China#cite_note-BBERG10012014-382

[4] https://data.worldbank.org/indicator/SE.ADT.LITR.ZS?locations=CN

China has widely invested in S&T: $163 billion in 2012[5] and $233 billion in 2016, which is about 2.1% of the GDP[6]. The country is second in the number of scientific publications and first in PhD engineers. Overall, S&T is an important part of national identity and integral part of achieving economic and political goals. These vast developments, economically and socially, provide an interesting setting regarding how S&T policies are made. China has changed rapidly over the last decades and S&T have been an essential part of this. In the following the structures and values surrounding this will be described. Also, this will lead the way to a description of current TA practices in China, their location as well as what future needs could be.

Policy making for S&T in China is part of the bureaucratic system, which formulates and implements policies in general[7]. S&T policies, like others, take shape through the interactions between scientific and political institutions, in which actors from the legislative, government, advisory bodies, conducting or funding organisations all play roles. The parliament and the highest level of state power, the National People's Congress (NPC) by use of the Standing Committee and the Committee on Science, Technology, Education and Health "has the authority to draft, enact, and amend S&T-related laws, which usually are drafted by a specific government ministry. Technically speaking, NPC also monitors the implementation of such laws and approves the state budget for science and technology affairs. Members of the Chinese People's Political Consultative Conference (CPPCC), an advisory body, many being non-Chinese Communist Party (CCP) member scientists and engineers, also voice their expert opinions and comments" (Liu et al. 2011: 919).

In the centre of the S&T government enterprise in China is the Ministry of Science and Technology (MOST), which conducts China's national S&T pro-

5 https://www.bloomberg.com/news/articles/2014-10-01/chinas-163-billion-r-and-d-budget
6 http://english.cas.cn/newsroom/china_research/201710/t20171020_184378.shtml
7 In March of 2018 the Chinese government issued a plan to reform the institutions of the government.

grams, including basic and applied research, commercialisation of S&T, backing of innovation within companies as well as support of science parks and incubators (Liu et al. 2011: 919). Correspondingly the mission of the Ministry reads: “MOST takes the lead in drawing up S&T development plans and policies, drafting related laws, regulations and department rules, and guaranteeing the implementation […] MOST aims to serve socio-economic growth by coordinating basic research, frontier technology research, research on social service, key technology and common technology.”[8] Here we again find close ties between S&T developments and economic growth.

A further important actor is the Chinese Academy of Sciences (CAS), which has a large advisory role to play regarding S&T policy making through its academicians providing services for decision making. CAS is active in “research, high-tech development, technology transfer, and training” (Liu et al. 2011: 920). In its own mission CAS understands itself as “the linchpin of China’s drive to explore and harness high technology and the natural sciences for the benefit of China and the world […]. Since its founding, CAS has fulfilled multiple roles — as a national team and a locomotive driving national technological innovation, a pioneer in supporting nationwide S&T development, a think tank delivering S&T advice and a community for training young S&T talent”[9]. CAS sees itself as driver for indigenous innovation and S&T developments in China as well as taking on an advisory role for policies in these areas.

Another central player is the National Natural Science Foundation of China (NSFC), which “mainly supports basic research and mission-oriented research projects through competitive and peer review processes” (Liu et al. 2011: 920). The NSFC is the institution which administrates the National Natural Science Fund for the Central Government, “supporting basic research, fostering talented researchers, developing international cooperation and promoting socioeconomic development”[10]. The administrative system in NSFC aims to

8 http://www.most.gov.cn/eng/organization/Mission/index.htm
9 http://english.cas.cn/about_us/introduction/201501/t20150114_135284.shtml
10 http://www.nsfc.gov.cn/english/site_1/about/6.html

improve decision-making in funding policy and implements as well as it monitors and consults. Also, here we find connections made between the economic developments for society and the importance of S&T for this.

The Chinese Association for Science and Technology (CAST) can be regarded as an umbrella organisation made up of various academic and professional societies (Zhu 2009: 72). It understands itself as the "largest national non-governmental organisation of scientific and technological workers in China, which also serves as the bridge that links the Communist Party of China and the Chinese government to the country's science and technology community"[11]. The societies of CAST, over 200, spread throughout China and allow for a wide network in the area of S&T. Overall, CAST is an important player in driving Chinese S&T development and has participated in shaping policies and regulations through its networks of scientists, engineers and other people working in S&T. Close ties to policy and decision making are provided by the constituent membership of CAST in the CPPCC. In its mission statement CAST describes itself as an organisation aimed at developing S&T in China, opening S&T up to a wider public as well as providing advice for the overall S&T strategies: "CAST devotes itself to boosting the development of science and technology in China and enhancing science literacy of the whole nation, organises and encourages scientists and engineers of the country […] to conduct academic exchange, science popularisation and scientific and technological consulting and other activities according to the country's science and technology development strategy, accelerate the emergence of scientific and technological talents, voice the opinions of science and technology professionals and firmly safeguards their legitimate rights"[12]. Again, we see here the alignment between strives in S&T and the development of China as well as communication and promotion of S&T in different areas. These organisations derive their legitimacy and standing from their activities for enhancing the development of S&T in China as a way to support the development of the country as a

[11] http://english.cast.org.cn/n214206/n214353/index.html
[12] http://english.cast.org.cn/n214206/n214353/index.html

whole. In this way, we find close links between the self-understanding of these organisations and the well-being and development of China.

1.1 Main Advisory Structures

In China, each main actor in the S&T decision making system has its own S&T policy research institution functioning as an advisory organisation constantly reviewing, evaluating S&T projects and drafting S&T plans. The following describes the institutions that can be considered to have TA-like roles within the Chinese system.

The Chinese Academy of Science and Technology for Development (CASTED), affiliated to MOST, is a key actor in providing policy advice for S&T and is therefore engaged in many TA-like activities. CASTED contributes to decision making by participating in the “formulation of all important national S&T strategies and plans, and has played crucial consultation and support roles for our S&T development” (International Innovation: 1). CASTED focuses on the development of an innovative society, the improvement of innovation capacities as well as on the provision of advice for a macro decision making level regarding S&T development. This also includes the societal level of S&T developments, “taking into consideration social needs and realities” (Zhu 2009: 77). CASTED’s key aims include providing studies and suggestions for the design of national S&T development strategies, conducting research for central and local government departments supporting national strategic decision making and policy, development of a core S&T strategy talent team as well as setting up an exchange platform to connect different research resources, networking international and national research. Further, the academic set up of CASTED, ranging from natural sciences, engineering, economics or sociology reflects an interdisciplinary approach needed for assessing S&T and providing advice. CASTED is made up of various institutes with one explicitly focusing on the relationship of S&T and society. The Institute of Science, Technology and Society at CASTED "studies S & T-related social development issues, including social science studies on risk and disaster, social environment of innovation, studies on scientific community, education, employment, non-governmental organisation, and frontier issues such as innovation culture, science ethics, and S & T and social inequality"[13]. Further, it assesses the social impact of S&T projects and gives policy advice also on sustainable development. These characteristics of CASTED show a close relation to TA or TA-like activities. Examples for TA-like activities include a national soft science program, which established an open exchange and stakeholder communication platform enabling debates on policy issues and expanding the consultation process. Another example is a foresight project on high-tech industries in China aimed at examining different fields of technology, which are of importance to social and economic development in China. Socioeconomic needs were analysed, surveys on stakeholder opinions were undertaken and a comprehensive investigation on the benefits and problems was conducted. This wide consultation and the focus on societal needs were unique parts of the foresight project, which helped identify national priorities and crucial developments (Zhu 2009: 79ff.).

The Institute of Policy and Management (IPM) of CAS established in 1985, offers research consultative services to central authorities, CAS, local governments as well as businesses. Its research areas include S&T strategy and planning; science, technology and society; S&T management and evaluation; intellectual property and S&T law; innovation and development policy; innovation and entrepreneurship policy; sustainable development strategy; energy-environment-economy; overall planning and management; policy modelling and simulation; urban development and regional management; and interdisciplinary studies of natural and social sciences. Sticking to key topics concerning national strategies of sustainable growth and rejuvenating China through science, technology and human resource development, IPM conducts strategic studies and offers strategy options with an important bearing

[13] http://2015.casted.org.cn/en/web.php?ChannelID=67

on the country's development by taking advantage of its academic build up in integrated and interdisciplinary studies, and renders strong support to make China a harmonious and innovation-driven society. Since its establishment, IPM has scored a large number of widely-acclaimed research achievements. Its annual report series, including the China Sustainable Development Report and the High Technology Development Report, have rendered support to the drafting of important national policy documents, such as an Outline for the National Medium- and Long-Term Program for Science and Technology Development (2006–2020) and the 12th Five-year Plan for Innovation Capacity Building in China.

The main responsibility of the Bureau of Planning within NSFC is to elaborate plans of NSFC, to comprehensively coordinate and direct the allocation of the funds, to compile the Guide to Programs and establish related criteria for compilation, to formulate guidelines for the application, evaluation and financing the projects funded by NSFC, to make comprehensive statistics and analysis on the achievements of the funded projects and to manage NSFC's peer review system, to manage the archives of the funded projects, to manage the local liaison units of NSFC. Another institution within NSFC is the Bureau of Policy, which analyses and studies the trends and funding opportunities for basic research in natural sciences at home and abroad. Further it analyses disciplinary policy, studies and establishes strategies, guidelines, and policies for the development of NSFC, proposes measures for perfecting the management system as well as operation mechanisms and assessment systems of NSFC to verify NSFC's regulation documents and coordinate the formulation of related policies. In addition, the Bureau of Policy is mandated to provide consultancy concerning significant S&T policies and to draft policy statement of NSFC.
The China Association for Science and Innovation Strategy Research Institute (NAIS) was established in August 2015, is directly under CAST. It's main responsibility is to focus on the strategic objectives of the national science and technology development, on the assessment of national-level innovation,

commitment to national scientific and technological innovation and development strategies, planning, plans, projects, bases, personnel, projects assessment tasks around the science and technology policy, science and technology human resources, science and culture, and science and technology development research community, for the community to provide third-party professional consulting and evaluation services, promote the establishment of a sound national science and technology assessment system to create a high level of technological innovation influential think tanks and international reputation.

Next to these institutions with various TA-like activities the China National Health Development Research Center (NHDRC), previously known as China Health Economics Institute (CHEI) can be named as well. It is a national research institution, established in 1991 under the leadership of National Health and Family Planning Commission of China (NHFPC) and works as a national think-tank providing technical consultancy to health policy-makers to further strengthen health policy research and better accommodate the needs of health development and reform. CHEI formally changed its name to the China National Health Development Research Center in 2010 after being approved by the Chinese Staffing Committee. NHDRC has a Division of Health Technology Assessment (DHTA), conducting health policy evaluation and technology assessment. Research Fields of DHTA include: impact evaluation research on health and family planning policies, public health programs and providing policy-makers with solid evidence on policy outcome as well as conducting assessment on the appropriateness of health technologies and advanced medical devices to serve decision-making over choice of appropriate technologies.

Further, The China Institute for Science and Technology Policy at Tsinghua University (CISTP), one of the top universities, was jointly founded by the Ministry of Science and Technology of China and Tsinghua University in 2003. It aspires to become a leading institution in S&T policy and development strategy through its research and educational activities. This includes monitoring S&T development trends and international S&T policy changes, engaging in academic research in S&T policy, providing graduate education and short-term training in S&T policy, facilitating international cooperation and communication between the domestic and international S&T policy community and providing consulting services to the government and industry in relevant areas.

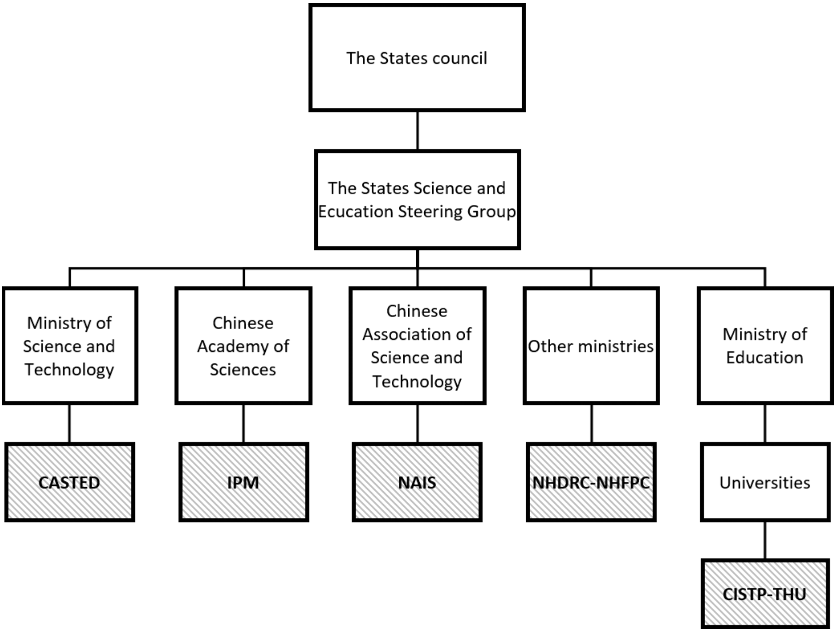

Figure 1: General structure of institutions. Areas of TA activities marked (own graph)

Overall, it can be stated that CASTED as it is directly affiliated to MOST is closer to decision making system and is more familiar with innovation policy and strategy making than other institutions. IPM is more academically oriented. This is because it is located within the CAS system and as such closer to research institutes and scientists. In general, NSFC is mainly focused on basic research. NAIS as part of CAST has close relationships with many other academic associations and societies. Beyond this, it also has access to scientific personnel in universities, research institutes, and enterprises including scientists, engineers, doctors, teachers, etc. Figure 1 gives and overview of main institutions and in which one's TA activities take place (marked).

1.2 The Role of Technology Assessment

TA as such does not exist in the Chinese system. Yet, as seen from the descriptions above, various TA-like activities take place in different institutions. These range from evaluation of research to monitoring of innovation or health assessment, often with a connection to global developments and competition. Not very pronounced are activities regarding the involvement of the public or stakeholders. In this way TA activities in China fit into the top down structure in which targets or policies are formulated at the top level (e.g. NPC) and then trickle down. Therefore, TA's role can be understood as part of this system, which places high emphasis on the further development of S&T in order to better China's competitive position or solve large societal issues. Evaluation and monitoring of policies, research, etc. are an important part of enabling these goals. In this sense TA's role in the overall structure tends to be that of a "reviewer" of these initiatives, often looking at the quantitative evaluation of future S&T developments. With the influence of a drive for economic growth, assessing a technology in China is often understood as measuring its economic or innovative potential. From a European understanding of TA, with its significant focus on societal aspects, the Chinese context would require a new term, not a simple translation. This is because the literal translation is mainly focused on the economic potential in the sense of an evaluation. Therefore, the use of the term TA if understood as it is in the European discussion, would require an addition or concretisation in Chinese to include the societal aspects and the possible impacts of S&T on society, stakeholders, etc. Therefore, TA in China is mainly understood as an evaluation of future (economic) outcomes of S&T also in a competitive situation with other countries. In recent years, with the development of China entering a new era, the government has paid more and more attention to the issue of unbalanced development and promoted the comprehensive development of economy and society. In the government departments, research institutes and social organisations a group of think tanks has been established. They are doing research with a combination of expert advice and social surveys continue to provide policy recommendations for policy-making departments. The research networks and platforms formed between these various types of think tanks will probably be the best areas for conducting technology assessments. Currently, CASTED seems like an appropriate place for TA to be further developed. This is due to is location as part of MOST, which gives it direct ties to decision making in S&T. Also, CASTED is active in technology foresight with a department in this area. Here the social-economic needs and S&T development trends are assessed using methods such as Delphi surveys, scenario analysis and technology road-mapping. Based on this, priorities of crucial technologies are set for policy making, especially for national S&T plans and for evaluations of high-tech developments. Though TA is not part of these foresight activities, it could be incorporated within CASTED.

2 Science and Technology Priorities and Values

2.1 Main Priorities in National Documents

In the Chinese system, there are several relevant official documents that show current priorities in S&T policies. The *National Long-Term Science and Technology Development Plan* (2006-2020) identifies 11 key areas for national economic and social development and selects from among them 68 priority topics that are likely to gain technological breakthroughs in the near future. The 11 key areas include: Energy, Water and mineral resources, Environment, Agriculture, Manufacturing, Transportation, Information Industry and Modern Services, Population and Health, Urbanisation and Urban Development, Public safety and National Defence. These key areas refer to industries and industries that focus on the development of national economy, social development and national defence and are in urgent need of support from science and technology. The priority topics refer to the technical group that needs urgent development in the key areas, clear tasks, good technical foundation and that can make breakthroughs in the near future. The determination of the priority topics follows these principles: First, it is conducive to breaking the bottleneck constraints and improve the sustainable development of economy. The second is conducive to master the key technologies and common technologies, improve the industry's core competitiveness. Third, it is conducive to solving major non-profit scientific and technological issues and improving public service capabilities. Fourth, it is conducive to the development of dual-use military and civilian technologies and the improvement of national security capabilities.

Further, the *13th Five-Year Plan for national development of science, technology and innovation* issued in 2016 focuses on building up national advantages and strengthening the strategic layout of both the present and the long term. For this, China will speed up the implementation of major national science and technology projects and start the "2030-Major Project of Scientific and Technological Innovation", build an industrial technology system with international competitiveness, strengthen the integrated deployment of modern agriculture, develop next-generation information technology and smart manufacturing and energy, promote disruptive technologies and innovation as well as speed up industrial transformation. Also, this plan aims to improve the technical system that supports the improvement and sustainable development of people's livelihood, break through bottlenecks in areas such as resources and the environment, improve population health and public safety and establish a technical system to safeguard national security and strategic interests as well as develop deep sea, deep earth, deep space and other areas of strategic high technology.

This five-year plan is based on certain principles, which show how the role of S&T is understood in policy making in China. These are summed up in the following:

(1) Adhere to supporting the country's major needs as a strategic task. Focus on the major needs of the national strategy and economic and social development, clearly define the main directions and breakthroughs; strengthen the core of common technology research and development and conversion applications; give open spaces to science and technology innovation for fostering and developing strategic emerging industries, promote economic upgrading and efficiency enhancement, leading the development of and the important role of safeguarding national security.

(2) Oblige to accelerating catching-up as the focus for development. Grasp the development trend of science and technology in the world, advance the planning and layout in the long-term development of the relationship, implement the asymmetric strategy, strengthen the original innovation, strengthen basic research, work hard in the original creation and comprehensively enhance the capability of independent innovation, and in important science and technology fields Achieve leapfrog development, keep up with and even lead the new direction of world science and technology development and master the strategic initiative of a new round of global technological competition.

(3) Science and technology for the people should be the fundamental purpose. We must closely follow the immediate interests and urgent needs of the people, integrate scientific and technological innovations with the improvement of the well-being of people and bring forth the scientific and technological innovations in improving people's living standards, enhancing people's scientific, cultural and health qualifications, promoting high-quality employment and entrepreneurship, helping the poor and poverty reduction and building a resource-saving environment-friendly society, so that more innovations will be shared by the people and they will have an increased sense of improvement.

(4) Insist on deepening reform as a powerful incentive. The reform of the scientific and technological system as well as the economic and social fields are essential. The decisive role of the market in allocating innovative resources should be accounted for as well as the role of the government in strengthening the market-oriented mechanism for technological innovation. This includes breaking down institutional barriers to enable in-depth integration of science and technology and economy. Support of breakthroughs and transformation of achievements are important and can form a dynamic mechanism for the management and operation of science and technology and further provide sustained momentum for innovation and development.

(5) Talent is an essential requirement. A priority development strategy for talented people should be implemented in order to put the development of human resources at the highest level of science and technology innovation. This includes finding qualified personnel in innovative practices, cultivating qualified personnel in innovative activities, fostering talent pools in innovative undertakings, reforming the mechanism for training of qualified personnel, and developing a large-scale structure to guarantee excellent quality of personnel.

(6) The global vision is an important guide. Take the initiative to integrate the global innovation network, optimise the allocation of innovative resources on a global scale, integrate scientific and technological innovation with the national diplomatic strategy, promote the establishment of a broad range of innovative communities and carry out scientific and technological innovation and cooperation at a higher level. This will help the aim of striving to lead in several important areas as well as becoming an important voice of discourse in global innovation governance.

These principles or characteristics show the importance of developing S&T in China, which is connected to the well-being of society and solving various challenges. It also become clear that China as a developing country is focused on “catching-up”, even becoming a leader, and sees the global level as a reference for this development.

Another important document is the *13th Five-Year Plan for the development of Chinese Academy of Sciences* (2016-2020). It identifies 8 major areas of innovation, which somewhat overlap with the other priorities described above. These areas are: basic and frontier crossing research areas, advanced materials, energy, life and health, oceans, resources and ecological environment, information, optics, electricity and space. The plan also places its priorities in the context of the needs of society such as areas of health and sustainability as well as economic and social development or national security. CAS's aim is to take on a leading and key role in China's major scientific and technological challenges also by focusing on modernisation and produce original achievements that have symbolic significance in building an innovative country. This includes approving of major strategic technologies and products that show output and benefits for more effective and middle-to-high-end technology supply in order to increase international competitiveness in S&T.

As these documents illustrate there are aspects, which are dominant in the debates on S&T policies in China. These are often understood in the context of societal challenges and how the further development of S&T and innovation can help tackle these, which is often the case in such strategic documents. Specific underlying values and principles, such as a strong belief in development or relying on S&T to solve problems, also show in these documents. This can be related to the idea of developmentalism, which is a key aspect in China (Zhao & Liao 2016). A strong belief in S&T (scientism) as well as top down management provide the basis for how these documents described policy approaches specific to the Chinese context. China has made great strides regarding the advancement of S&T, becoming an important global player. These documents reflect the drive to enhance national S&T also as a way to remain competitive.

2.2 Values leading S&T Debates

Underlying the priorities described in the S&T plans are overall values in the Chinese context. These can be found in the Constitution and have developed over time. Historically, mainly three influences regarding current values can be identified: “traditional Chinese values, Western values imported since 1840, and new values grown in contemporary Chinese society” (Ma et al. 2015: 75). Traditional Chinese values are influenced by the culture of Confucianism-Buddhism-Taoism, which focuses on the individual as the basis of judgments and extends this to a wider scope (e.g. to the family, to the state, even the entire world). This takes the value system from the individual and extends it to community. Modernisation on a global level made it steadily possible for Western values to come to China, including an affinity for Western S&T, ideas of freedom, equality, or prosperity as well as “concepts of rights and legal awareness has taken root in Chinese society and constitutes an important criterion for value judgments by the public” (Ma et al. 2015: 75). In contemporary China, the socialist market economy has created new conditions which also bring about new values. These are somewhat conflicting between socialist ideals of common prosperity and harmony and market-oriented principals of individual success and competition, yet they also have a common denominator of economic development. Further, the values surrounding the concept of sustainable development have also had influence. This describes briefly the context of the Chinese Constitution and the values conveyed in it. Beginning with the depiction in Article 1 the Constitution describes that “The People's Republic of China is a socialist state under the people's democratic dictatorship led by the working class and based on the alliance of workers and peasants”. The socialist economic system is based on the idea that “socialist public ownership of the means of production, namely, ownership by the whole people and collective ownership by the working people” (Article 6). Article 7 describes that the “State-owned economy, that is, the socialist economy under ownership by the whole people, is the leading force in the national economy". This relates to the traditional values of collectivity described above, in the sense that this socialist approach puts the collective interests of society at its centre moving past limits of individuals.

The main values in the Chinese Constitution can be described as: progress, affluence, peace and safety as well as harmony[14]. Progress towards a higher stage (e.g. from capitalist to socialist to communist society) has a key position in the Constitution, finding its expression in Article 14: "The state continuously raises labour productivity, improves economic results and develops the productive forces by enhancing the enthusiasm of the working people, raising the level of their technical skill, disseminating advanced science and technology, improving the systems of economic administration and enterprise operation and management, instituting the socialist system of responsibility in various forms and improving organization of work". Here we see a close connection between economic and educational progress and the well-being of society as a whole. Further the importance of S&T in the context of progress is emphasised. In order "to improve productivity and the development of productive forces in society, it is necessary to popularise knowledge of and skills in advanced science and technology […] enthusiasm and support for scientific progress serve as manifestations of the importance of this concept of value" (Ma et al. 2015: 77). Affluence is a further important value represented in the Constitution, especially regarding modernisation and advances in industry, agriculture, defense, education, S&T. Here the connection is made between development in these areas and overall improved living standards for citizens as well as Chinese independence and self-reliance. Article 20 states that: "The state promotes the development of the natural and social sciences, disseminates scientific and technical knowledge, and commends and rewards achievements in scientific research as well as technological discoveries and inventions". The connection between affluence, the well-being of society and

[14] The 12 core socialist values, which summarise the nation, society and individuals, comprise a set of moral principles, were defined by central authorities at the 18th National Congress of Communist Party in 2012, including: prosperity, democracy, civility, harmony, freedom, equality, justice, the rule of law, patriotism, dedication, integrity and friendship.

S&T and innovation can be seen in the focus on strengthening indigenous capabilities. The values of peace and safety have a longstanding tradition in Chinese society, giving an importance to citizens' health in the constitution (e.g. Article 21). Harmony in the sense of a coexistence of humans and nature gives issues of sustainability an important role ("The state protects and improves the living environment and the ecological environment", Article 26). This is also extended to a harmonious society, as (Ma et al. 2015: 79) describe a speech given by then president of China Hu Jintao. The characteristic of a society in harmony include: "democracy and the rule of law, fairness and justice, integrity and friendliness, vigour and drive, peace and order, and harmony between man and nature". With rapid economic development in China, this can be problematic especially regarding environmental issues, yet at the same time the values around harmony frame the reactions to these challenges. These values are the frame under which the Constitution can be understood and which form its basis. They also form the basis of policy decisions made by the government as well as how these decisions are regarded by society as a whole. In the context of S&T, "Progress, affluence, peace and safety, and harmony are the four values identified in the Chinese Constitutions that relate to people's ethical considerations of science and technology development" (Zhao & Liao 2016: p. 80) and therefore form important reference points.

The Constitution shows the main values and emphasizes what China as a country stands for politically and culturally. Regarding the recent rise of China as a global actor, the economy is of main significance here. This in turn also relates to S&T developments. China has emerged as a major player in the world economy expanding by an average of 10% a year over the last decades, rising as a major exporter, increasing its income per capita. "China's 'open door' policy has been an integral part of economic reform. Adopted in 1978, it has resulted in a progressive opening to foreign trade and investment and culminated in China's accession to the World Trade Organization (WTO) in 2001. Through its acceptance of globalization, China has become the most open of the large developing economies. In some respects, China today is more open than a number of significantly more developed market-based economies” (OECD 2007: 11). Overall, the Chinese economy has gone from an agricultural to a services one, based largely on manufacturing. Regarding S&T, “China has relied heavily on technology imported from abroad, and the development of its scientific and technological capability has until recently lagged behind its economic growth. This trend was reversed towards the end of the last decade and since then significant progress has been made towards developing the country’s innovative capabilities” (OECD 2007: 9). The close connection between the economic development and strives in S&T and innovation is not only limited to the Chinese context. Often S&T policies are closely connected to the aims of pushing S&T developments, coming to more innovations and eventually achieving more economic growth. Together with the decision to reform the economic system, “institutional reform of the S&T system was launched in 1985. The primary goal was to overcome the separation of R&D from industrial activity, the key shortcoming of the pre-reform S&T system [...] these reforms gradually enhanced the economic orientation of the S&T system by introducing elements of competition and market discipline. Major institutional innovations have included the establishment of a variety of government R&D programmes, the emergence of markets for technology and of non-governmental technology enterprises” (OECD 2007: 44). We see here the close ties between economic goals and corresponding S&T policies.

To understand national debates and priorities on S&T in China it is important to take three characteristics of S&T management into consideration. This is “shaped by developmentalism, scientism and top-down management” (Zhao & Liao 2016: 2). In the context of developmentalism the idea of S&T policy serving economic development is often stressed since economic growth is the prime goal as described above. A Chinese study on the public perception of Science from 2010 shows that “89% of the Chinese agreed that Science and Technology will make our lives healthier and more comfortable”[15] (Zhao & Liao 2016: 3). This strong belief in S&T or scientism can be found among the

[15] Compared to the European public in 2010, where only 66% agreed with this statement (European Commission 2010: 32).

public as well as the government and coincides with the idea of S&T bringing economic and also social development. Also connected is the top-down management system of policy making in China. Here, the government plays the main role in making decisions and policies, resulting in a comparatively weak market or public. Therefore, public participation in S&T decisions is still rare. Yet, "the rapid social transition in China has led to a series of changes in the attitudes towards and behaviour related to responsibility of innovation of various stakeholders, including public, scientific community, enterprises and government" (Zhao & Liao 2016: 4). There are still strong 'traditional' discourses and structures that continue to shape S&T policy making in China, yet it also appears there is an opening-up and an awareness that changes towards more institutionalized forms of advice (e.g. TA).

2.3 Examples of Values in S&T Priorities

A current example of a S&T priority (and the surrounding policy setting) is artificial intelligence (AI). The development of this field corresponds with Chinese priorities on the advancement of S&T and taking on a leading role in this, also as an element of economic growth. On July 8th, 2017, Chinese government published "The development plan for new generation of artificial intelligence".[16] In this plan, different priorities[17] have been proposed, which can be connected to main values discussed above. A first aspect of this plan is the advancement and excellence of S&T also in regard to international competition. The plan states that it aims to "systematically improve the capability of

[16] http://www.gov.cn/zhengce/content/2017-07/20/content_5211996.htm#

[17] These include: constructing open and cooperative artificial intelligence technology innovation system; fostering high-end and efficient smart economy; building a safe and convenient smart society; strengthening military and civilian integration in the field of artificial intelligence; building ubiquitous security and efficient intelligent infrastructure system; prospecting the layout of a new generation of artificial intelligence major science and technology projects.

continuous innovation so as to ensure that the level of Chinese artificial intelligence science and technology ranks among the highest in the world". This emphasis on technology advancement represents the value of progress, also through the construction of an infrastructure for research. Progress here is seen as being part of the best worldwide regarding the level of research. In this sense, it also means progressing to be a leader in this area and setting the tone. This of course can also be related to affluence and prosperity, since only through advancement and being internationally competitive can China gain from its developments in artificial intelligence. This also shows in another priority of the plan: "Artificial intelligence has become the new engine of economic development. Artificial intelligence, as the core driver of a new round of industrial transformation, will further release the tremendous energy accumulated by scientific and technological revolutions and industrial changes and create new and powerful engines to reconstruct all aspects of economic activities". Again, affluence and economic development are a main focus here as well as a main justification for developing this technology further.

Next to these somewhat unsurprising priorities for the advancement of AI for China such as growth, leadership in this area and using this technology to create new economic possibilities, the plan also takes up societal aspects. This can be regarded as a novel aspect, since it is possibly the first time a national S&T plan has taken this up. In the plan "double attributes" are presented, which means "high integration of AI's technical and social attributes". In this case, the plan emphasis: "It is necessary to intensify the research and development and application of artificial intelligence, to maximize the potential of artificial intelligence, to predict the challenges of artificial intelligence, to coordinate industrial policies, to innovate policies and social policies, to achieve coordination between incentive development and reasonable regulation, and to guard against risks to the maximum". This reflects the value of peace and safety since it emphasises the need for such a technology to be assessed also according to societal or ethical aspects. The plan takes up the creation of safe and regulated forms of AI, also considering possible effects, and developing polices accordingly shows that the values of peace and safety have an important role here.

Of course, as this example shows, the development of S&T (such as AI) also means that values may contend one another and that they are not clearly differentiated. How they relate to each other, for example if progress may affect peace and safety, remains open. This also points to the needs for TA, in the sense of providing options and balancing them. This plan shows that issues of societal implications of S&T are relevant and on the radar of policy makers, yet it seems unclear how these will be further debated, balanced or even resolved.

3 TA State-of-Art: Methodologies and Impact

Even though the term Technology Assessment is largely unknown in China, there are still various activities taking place that can be regarded as TA. Against the background of developmentalism or a strong top down structure, TA is bound to be conducted in different ways than in other countries, where different characteristics dominate. Since TA as such is not established in China, looking at key institutions in the Chinese S&T setting can help identify TA-like undertakings and functions as well as the actors involved.

3.1 TA as Policy Advice

A main function of TA is to provide policy advice regarding interests of the public as well as political decisions. A main institution and actor with this function is CAS, which has been key to China's S&T planning. Next to other roles, CAS can be understood as a think tank delivering S&T advice. In 1956, the central government asked CAS to oversee the preparation of the country's first 12-year national programme for S&T development, which fostered

China's drive for modernization of S&T. Since then, CAS has participated in the preparation of all national S&T development plans, serving as a key national think tank. Its proposals have resulted in the launch of a number of key national scientific programmes including the "863 Program" in 1986, which has pushed China's overall high-tech development and the "973 Program", or National Basic Research Program, in 1997, which called for the development of S&T in various fields. Its goal was to align basic scientific research and innovation with national priorities in economic and social development[18].

An important example of TA activity was the Wenchuan rapid assessment survey by CASTED, which conducted a wide field survey on the people affected after an earthquake in the Wenchuan County in 2008. Needs assessments by direct participation of the local people were done and the findings were taken into account for the reconstruction plans. A foresight project on high-tech industries in China aimed at examining different fields of technology, which are of importance to social and economic development in China. Socioeconomic needs were analysed, surveys on stakeholder opinions were undertaken and a comprehensive investigation on the benefits and problems was conducted. This wide consultation and the focus on societal needs were unique parts of the foresight project, which helped identify national priorities and crucial developments (Zhu 2009: 79–84). CASTED has conducted large-scale research and assessment on technology policies in the 1980s, covering 12 national key fields, participated in making the national S&T development plan from the 7th to the 11th Five-Year Plan period and played an important role in the strategic research for the Outline of the National Program for Long- and Medium-Term Science and Technology Development (2006-2020). Also, CASTED participated in assessments and studies on a series of key projects, including economic evaluation and social issues investigation on the Three Gorges Project, studying the technological and economic issues of the Beijing-Shanghai High Speed Railway Project, social and economic impacts of the west line of South-to-North Water Diversion Project and the development of the Large Aircraft

[18] http://english.cas.cn/about_us/introduction/201501/t20150114_135284.shtml

Project. Further, CASTED focused on promoting social development through S&T by conducting exploratory research on S&T risks and social governance. CASTED was also tasked with conducting comprehensive research on the S&T management mechanism reform, which included the reform of research institutes, the transformation of technological achievements, increasing collaboration among industries, universities and research institutes as well as S&T assessment and awarding systems.

Overall, TA as policy advice in China, as the activities by CASTED show, has to be considered in the wider context of S&T. As described above economic growth and prosperity continue to be defining aspects of S&T and their assessment in China. This shows challenges of TA in China understood as policy advice. Government leaders seem to be mainly concerned with S&T advancement and the economic potential of new technologies. As these are the main addressees of policy advice this reflects in the way assessments are done and what they focus on. Currently the main focus of TA in China in this context is therefore on the economic aspects of S&T. Social impacts and possible risks of new technologies have not been sufficiently considered. Further, the lack of institutions and systems that can ensure TA activities and research are even done also poses a challenge for TA as policy advice in the Chinese context.

3.2 TA in Public Debate

The top down structure of decision making in China gives the main role in decision-making to the government. Over the last years it has significantly changed and also improved the lives of millions of people, mainly by lifting them out of poverty, yet it also seems to be increasingly faced with questions from the public as well conflicts regarding issues like well-being or air quality (Zhang & Barr 2013: 134). This also points to the growing importance of forms of engagement in China, also regarding S&T developments, which shows a main function of TA in public debate. Participatory TA aims to involve a larger spectrum of society and with this, making decisions more robust as well as legitimate. In the Chinese structure, which is very much dominated by top down and developmentalism, a certain degree of public inclusion becomes necessary and as it seems will also eventually be demanded. This presents a unique setting for participatory TA between restricted structures and tendencies towards opening dialogue with wider society. Since S&T developments have the potential to create issues, which concern a wider public, TA has a specific role here.

Movements towards more public communication and participation in China can be seen in the role of non-governmental organizations (NGOs), for example in the context of environmental issues (Zhang & Barr 2013). In the Chinese context, NGOs present actors that can disseminate ideas, provide empirical evidence as well as support the "creative search for alternative solutions. [They] have served to empower the general public and restrain government authority" (Zhang & Barr 2013: 133). It seems that the Chinese government will have to adapt to a growing civil society and empowered citizens, with various actors stepping into decision making processes. Especially pressing environmental issues such as air pollution provide a ground on which a growing awareness of the public is especially apparent in China. Here the effects of demands for economic growth and S&T developments as well as their societal implications become obvious. A gradually pluralized political setting will continue to emerge, creating challenges for the government and its decision and policy making structures. The idea of "authoritarian deliberation" as described by (He & Warren 2011), focusing on China, brings together the apparent paradox of authoritarian rule and deliberation. They connect cultural specifics in China to the top down structures resulting in deliberation or engagement actually making authoritarian rule more resilient and adaptive.

Participation in the Chinese context can mainly be understood as communication (or science popularization), with some areas that are highly disputed and pressing (such as environmental aspects or GMOs). In this setting, it remains unclear whether participation could actually challenge or alter (established) practices of S&T decision making or if it will be increasingly used to stabilize a top down structure. Further, TA's role here remains unclear: How can inclusion of a wider level of stakeholders within the policy setting be enabled? Especially in the Chinese context, there are tensions and pressures that can make for interesting spaces of engagement. Here, TA with its wide experiences in ethical reflections and how to include this into policy can offer useful ways forward.

Perhaps the most important example of an engagement event to mention in the context of participatory TA in China is a consensus conference in Beijing on genetically modified food conducted in 2008 by researchers from CAS. Here, interested citizens as well as scientists working in the field gathered for discussions on the technical aspects as well as the societal implications of this complex S&T issue. Important was that the CAS researchers were trusted by both sides and therefore could facilitate. Yet, it remained difficult because the participants weren't familiar with the method of consensus conference and therefore not accustomed to taking part in discussions with one another. This event remained the only one of its kind.

3.3 TA in the Engineering Process

TA as part of the engineering process is not known as such in China. Socio-economic or environmental risks assessments are conducted, as in arguably any country today dealing with S&T developments. Yet, in the context of TA there are no clear standards or methods for this as part of an assessment within the development process. Of course, we do find similar problems, reactions or issues regarding S&T developments and therefore require some form of assessment as part of the engineering process. This is especially apparent in the context of large-scale infrastructure project, which can lead to debates or even protest of effected parties. This should be further examined in the Chinese context, also as a way forward regarding useful forms of TA in engineering processes.

As mentioned, this area of TA is difficult to locate in the Chinese context. As mentioned, TA isn't a common term in the country and often activities can merely be related to TA. Regarding TA in the engineering process Health TA (HTA) can be mentioned. HTA was introduced into China end of 1990s. The National Health and Family Planning Commission gradually realised the importance of HTA and since 2000 it has been included in each year's key points of health work. Main institutes working in this area are the Ministry of Health (MOH), The Shanghai Clinical Research Center (SCRC), China National Health Development Research Center (CNHDRC), or The Zhejiang University Biomedical Engineering technology assessment centre.

The other area need to be mentioned is Environmental Impact Assessment (EAI). In 2002, the state enacted the Environmental Impact Assessment Law and in 2016 this law has been revised.[19] EAI in this law means to assess possible environmental impact of plans and construction projects. In Article 5, it says "Government encourages related institutions, experts and public engaging environmental impact assessment in appropriate ways." In the Ministry of environment protection (MOEP) there is a department of environmental impact assessment which is in charge of regulating, management, organizing and implementing EIA.[20]

Besides, there are 51 standards and technical guidelines regarding EIA from the year of 1993 to 2017. For example, Technical guideline for environmental impact assessment (HJ/T 2.1-93); Technical guideline for environmental impact assessment (HJ 2.1-2011); Technical guideline for environmental impact assessment of construction Project-General Programme (HJ 2.1-2016); Technical Guidelines for Plan Environmental Impact Assessment General principles (HJ/T 130-2003, HJ 130-2014). [21]

[19] http://www.zhb.gov.cn/gzfw_13107/zcfg/fl/201609/t20160927_364752.shtml
[20] http://hps.mep.gov.cn/
[21] http://kjs.mep.gov.cn/hjbhbz/ (in Chinese)

3.4 TA Roles Matrix

In China, the impact of TA is mainly in the area of raising knowledge, especially regarding scientific assessment (e.g. monitoring of S&T developments) and policy analysis (e.g. assessment of innovation policies). This results from the top down structure as well as the strong emphasis on development of S&T, in which TA's role is often to support these efforts. Even though there are activities in the area of agenda setting and stimulating public debate (e.g. CAS consensus conference) this role for TA is still rare in China. This is also the case for mediation and re-structuring of public debate as overall the role of forming attitudes and opinions isn't a priority for TA activities in China. As for initialising actions, TA does reframe the debate by providing input for policies (by institutes such as CASTED, IPM or NAIS) and possibly new orientation or emphasis. Yet, introducing new decision-making processes or actual decisions that are taken is not a role that TA in China currently has. As mentioned, this doesn't necessarily correspond with the overall structure in the Chinese S&T system.

From these current roles of TA activities in China come future needs. Regarding TA's role as providing policy advice, it will remain to be seen how the main addressee of these assessments will enable the inclusion of wider issues. As mentioned, a challenge is the focus on economic development and potential of S&T from the government side. Societal aspects seem to be gaining importance, but in the setting of developmentalism and a top down structure this may not often be a priority. Further, there is a certain degree of opening up towards the inclusion of public opinions into the decision and policy making process. This creates a certain tension between a top down organisation and growing demands for inclusions (e.g. regarding environmental issues). This can lead to an authoritarian deliberation, which actually reinforces the top down structure. Here TA would embark on a new role, in which, for example, it introduces new forms of engagement or helps intensify public debate but not, as in European TA understandings, as a democratic pluralistic force. This creates an especially interesting setting for (future) TA in China, since it remains to be seen what TA's actual role will be when certain debates open up to a wider audience. Future desirable roles for TA would then be to mediate, "build bridges", enhance social awareness and consensus especially regarding the challenges of including more societal actors in S&T decision-making.

Chinese values such as progress and affluence also shape the roles of S&T (as bringing economic prosperity and development) as well as those of TA. Harmony as a key element also means that TA should see its role in shaping ways to mediate between different stakeholders in the Chinese context. The strong emphasis on developmentalism and scientism means that TA could ideally develop alternatives to provide options for decisions, even within top down structures. Further, as described going beyond communication as the main way of interacting with a wider public could also expand how S&T are embedded in society and shaped according to needs and expectations.

4 Chinese Perspectives for Global TA

In recent years, China proposed working to build a community of shared future for mankind, which means a world with lasting peace, common security, common prosperity, open and inclusive, clean and beautiful. For this, China implemented the Belt and Road Initiative with the aim of establishing cooperation with other countries.[22] This coincides with the concept of "community of human destinies" meaning that the major challenges facing the world nowadays are not the ones that a single country can handle alone. Therefore, common, global approaches are required. Under the guidance of this concept, China will continue to promote economic and technological cooperation with all other countries in the world and establish a global governance system. Global assessment and governance of S&T is an important aspect of this

[22] http://www.xinhuanet.com/english/2017-01/19/c_135994707.htm

system. For example, the National Natural Science Foundation of China specifically funds international projects. This is a main activity and includes collaborations like the Sino-German Center for Research Promotion, which is jointly funded by NSFC and German Research Foundation (DFG). It aims to support cooperation and exchanges between researchers and is focused on various areas such as new materials, information science and communication technology, Nano-technology, energy research, environmental research, life sciences, advanced manufacture technology or transportation studies. Of course, any of these areas would also require TA research and in several there is extensive European and German experience in assessing S&T according to societal issues (e.g. energy, Nano-technology, transportation). Here there could therefore be a Sino-German platform oriented along the areas mentioned, which enables TA research as well as exchange of experiences. This shows a need from the Chinese side to include TA in the existing S&T collaborations.

As with any country, China has specific political, cultural and historical characteristics, which shape its internal structure as well as S&T priorities. As described above, these are often focused on further (economic) development of S&T. With a status as a developing country this isn't very surprising. The argument is that a certain level of development has to be reached before possible issues of undesirable outcomes can be contemplated. This is for example the case in the United Nations Framework Convention on Climate Change in which China is regarded as a developing country. As China soars to the second largest economy in the world and has made tremendous achievements in economic and technological fields in recent years, it has also placed more and more emphasis on the coordination and sustainability of development. China's national leaders put forward "Clear waters and green mountains are as good as mountains of gold and silver."[23] In this sense, China is pursuing green and low-carbon development and works to implement the Paris Agreement.

[23] http://www.xinhuanet.com/english/2017-01/19/c_135994707.htm

These developments would also have implications for any TA activities on a global frame, with both “first world countries” as well as “developing” ones. This raises further questions regarding the understanding of the country by itself as well as by others. The status as a developing country comes from the assumption that development (e.g. economic or technical) is a logical next step. Development of food technologies brings security and prosperity to otherwise neglected regions. Yet this can of course be questioned especially regarding issues like sustainability. Further, the strong emphasis on development would surely influence any participation of China in a global TA project, which coincides with the importance of scientism in China as described above. TA as practiced in many European countries questions a technocratic approach to challenges, the technological solution isn’t necessarily without (unintentional) consequences. In this way, TA may question the strong belief that science and technology will offer the best or more robust solution. This could create tensions for a Chinese participation in a global TA project.

China is a socialist country with the aim of achieving common prosperity of all the people, which was a challenge for a long time. And as a big country, China is facing and trying to solve the problem of uncoordinated development in different regions. The experience of balancing excellent and coordinated development of regions at different levels, could help the deliberation between developed and developing countries in a global TA project. Because neglecting the differences in economic strength, the levels of development and the interest demands in different regions and countries will make it difficult to achieve substantive results in international cooperation. Overall for a global level, all possible compromises must be made on the premise of guaranteeing the independence and peace of the country, on the premise of safeguarding the core interests of the country. The territorial integrity, political consolidation and international competitiveness of a country are the basic guarantee for a country's sustained and steady development and the core interests of the country.

These national characteristics also give areas of compromise or non-compromise for Chinese participation in a global TA project. In China, there is a certain degree of "opening up" S&T decision-making debates to a wider public. This comes from various developments and poses a new situation for policymakers. Here, there could be compromises regarded the possibility of new ways of including, for example citizens. There is a growing awareness among the public, but also the government that inclusion or deliberation is necessary. Yet, this may differ substantially from deliberation or engagement in a European context. Even though there are many unanswered questions regarding the integration of deliberation into different forms of government, there is a certain basic assumption (even an ideal) of engagement (as conducted e.g. in Europe) that is grounded on the idea of transparency and democratic debate. As mentioned this may be difficult to realise in the Chinese context, which can offer transparency to a certain degree (as any other country), but may have issues with ideals of democratic deliberation or debate. In China there is a "shift towards a more inclusive perspective is likely to be driven by pragmatic concerns over (material) well-being of the public, and is a response to destabilizing problems caused by science and technology" (Wong 2016: 160). In this sense, the main motivation for engagement would be to collect the public's opinions on decisions that have already been made. There is awareness of the importance of actually engaging the public within a general lack of a culture of engagement and lay ethics in China. This shows the tensions in a system, which is still overall top down, but where more and more actors (e.g. experts in S&T policy advice, citizens, scientists as well as decision makers) are realising the importance of finding ways to open up these decision processes as least to a certain degree. This of course presents a challenge for TA, which is grounded on ideas of actual engagement and has historically emerged in Western democracies (Grunwald 2018).

This situation in China can be described as follows: "governance-level participation is developing in the absence of regime-level democratisation, combined with a high degree of experimentalism with consultation, deliberation, and limited forms of democracy” (He & Warren 2011: 271). In this understanding deliberation or engagement is done for functional reasons as a way to respond to growing pressures due to complex situations with many actors and ambivalent outcomes. More and more "the government will need to adapt to an expanding civil society – one that plays a greater role in the bargaining processes so typical of Chinese policy making [...] the government is learning to stomach an increasingly pluralised political sphere" (Zhang & Barr 2013: 135–136). In the light of this, the government may rely on deliberation or engagement in anticipation of possible demands for empowerment and as such creates a connection between its authoritarian structure and deliberation. Features of deliberation that are rooted in Chinese culture are for example responsiveness and attentiveness and there are examples of deliberation activities such as public hearings or elections. Yet the overall result is authoritarian deliberation as the outcomes remain within the context of government approved agendas and control (He & Warren: 2011). This then changes the assumption of engagement or TA being directly connected to democratic (Western) structures and only possible within these. This assumption could hinder global developments towards more responsible developments of S&T as it wouldn’t allow for an alternative normative basis (Wong 2016: 155). Therefore, TA should explore how it can be adapted in a context such as the Chinese one, also as a way to reflect on normative foundations and underlying values and how these can provide a basis for TA approaches.

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Technology Assessment in India

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1 Introduction

A discussion on India, anywhere, often starts with the acknowledgment that it is the largest democracy (in terms of population) in the world with a rich diversity of cultures, knowledge, and values. A critical extension of that discussion would also entail that India is a country of contrasts with huge inequality (Narsimha 2008). On one side, many people from Indian origin are making to the world's richest peoples' list, on the other side, there are millions of people living in acute poverty. India is the 7th largest country in the world in terms of area. As per the recent estimate, India has a population of over 1.35 billion, making it the second most populous country after China and the largest democracy of the world. The country has a quasi-federal system of government with parliament as the highest decision-making body. Since 2001, India has remained one of the fastest growing economies in the world with 9% GDP growth, punctuated by fluctuations and even reaching a record high of 10 % in 2010. The country is also successful in reducing poverty from 70 % in the year 1947 to 22% people living below poverty line in 2012. There are, nonetheless, regional variation and also misallocation of welfare funding to various states and poverty is still high considering the absolute numbers (GOI 2017). Thus, there have been increasing inequalities in income distribution as reflected in Gini coefficient of 32.5 in 1999 to 35.2 during 2010-15 (UNDP 2016) and jobless growth as a major concern in the organized sector.

India has a well-developed S&T infrastructure and is providing services to the world with its highly educated workforce. Yet, there are ongoing challenges of malnutrition, access to basic healthcare and clean water for millions of people. Developing policy for such a diverse, large and contrasting set of people is a daunting task. However, despite these challenges policy-making and planning were always central to the Indian democratic set-up, pre- and post- independence from colonial rule in 1947. This paper focusses on the role of Technology Assessment (TA) in Indian S&T and science policy set-up. The term TA has both broad and specific implications based on its country-specific and issue specific usage. In India, although, there is little recognition for the name TA, many activities undertaken by the government or private organizations could be categorised as serving a TA-like function. This paper, in the following sections, will unpack different meanings, underlying values, institutional mechanisms, and functionalities of TA-like activities in India.

2 Science and Technology Policy Structures and Technology Assessment

In general, TA is often associated with parliamentary committees devoted to advising the government, in order to make informed decisions on the strategic priorities, funding, and implementation of S&T (Sadowaski & Guston 2015). The Office of Technology Assessment (OTA), established in the 1970s in the USA is regarded as the first institution of this kind followed by many institutional set-ups in Europe (Hennen & Nierling 2015). In the Indian context, S&T is given a key role in the planning for economic growth and progress, as discussed further below. Science advice in India is institutionalised through national, state and department level committees. These committees eventually led to the development of major S&T and policy institutions such as Department of Science and Technology (DST), Council of Scientific and Industrial Research (CSIR), Indian Institute of Technology (IITs) and Technology Information, Forecasting and Assessment Council (TIFAC). These institutions have regular interaction and representation in the apex committees in order to streamline the development of S&T policy (Sikka 1995a). On multiple occasions, different committees functioned along with the support of major policy organisations of the government such as the planning commission (functional till 2015) and now the think tank National Institute for Transforming India (NITI Aayog). Other than apex committees, specialised national commissions such as space, atomic energy, science and engineering academies and national and state S&T councils regularly engage in science advice (Chidambaram 2015). The Technology Information, Forecasting and Assessment Council (TIFSC) was established under the Department of Science and Technology or in the executive branch of the government in the year 1988. It is important to note here that the concepts of technology assessment and foresight were integrated into one single organisation. Moreover, India has a broad spectrum of S&T infrastructure starting from grassroots technologies and traditional knowledge to modern S&T with most advanced space and nuclear technology. Traditional knowledge has a holistic perspective where technology assessment evolves along with these technologies. The figure (1.1) below summarizes the broad structure of S&T policy advice in India.

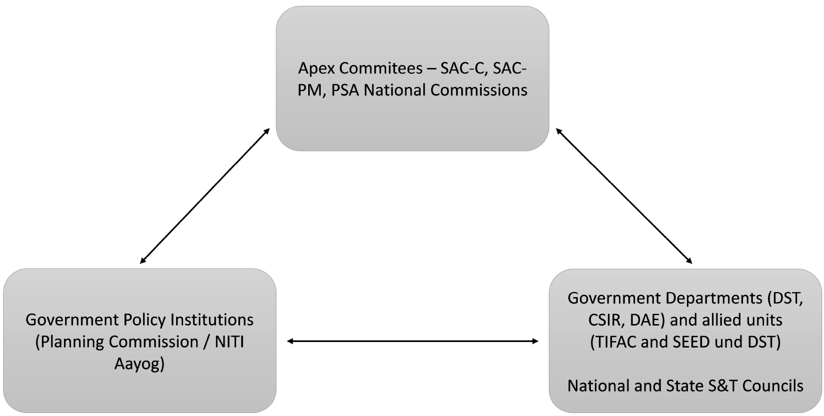

Figure 1: Science and Technology Policy Advice in India (Authors' compilation from various sources)

The government of India has set-up many apex science advisory committees and many subject-specific high powered committees, in order to guide the parliament in taking important science policy decisions (Sikka 1995b). These committees have been functional under various names since 1948 (Sikka 1995a). Majorly, three types of national-level committees and one state-level committee giving science advice to national and state level politics have been reported in the literature (Lavakre 1989; Sikka 1995a, b; Rao 2008; Jamal & Mandal 2013). At the national level, there are The Science Advisory Committee to the Prime Minster (SAC-PM), Science Advisory Committee to the Cabinet (SAC-C) and the recently created office of Principal Scientific Advisor (PSA)[1]. The office of PSA acts as a secretariat for SAC-C and helps in co-ordinating S&T decision-making in the country[2]. These three committees collectively advise the government on matters of science policy and act as the interface between government and all the major scientific institutions (Sinha 2018). PSA and SAC-PM are responsible for formulating various policies related to S&T, while SAC-C is responsible for their proper implementation. The state S&T councils often have regular meetings with SAC-PM for the implementation of S&T vision and goals at the state level[3]. The Advisory Committee for Co-ordinating Scientific Research (ACCSR) was the first apex science advisory committee of independent India. ACCSR was chaired by the then Prime Minister Jawaharlal Nehru with a focus on helping the government to build scientific institutions and establish co-ordination between different and fragmented scientific activities (Heptullah 1986). These represent main committees important in the Indian context. A detailed list of the different national level committees and their role in science advice is given below.

1 This post was created by Prime Minister Atal Bihari Vajpayee in 1991 (Sinha 2018). For further details on the role of PSA http://psa.gov.in/node/177

2 http://psa.gov.in/sac-c-advice-to-goverment

3 For details of a recent such meeting please visit KSSTC website link

Table 1.1: Different national committees that provide science advice to the government (Rao 2008; Mashelkar 2008; Narsimha 2008; Sikka 1995a, b)

	National Level Science Advisory Committee	Years Active	Chairman	Goals and Major achievements
1.	Advisory Committee for Coordinating Scientific Research (AC-CSR)	1948-1955	Pandit Jawaharlal Nehru	Promote institutionalization and organization of science in India
2.	Scientific Advisory Committee to the Cabinet (SAC-C)	1956-1968	Dr. Homi Bhabha	S&T cooperation with international organization, promote scientific and technical activities
3.	Committee on Science and Technology (COST)	1968-1970	Dr. B.D. Nagchaudhri	Recommendation for national science and technology council
4.	National Committee on Science and Technology (NCST)	1971-1974	C. Subramanian, T.A. Pai, P.N. Haksar	S&T Plan, State Science Councils, Science and Engineering Research Councils
5.	National Committee on Science and Technology (NCST)	1975-1979	P.N. Haksar, V.G.Rajyadhyakasha	Panel report on futurology for education, transportation, communication, housing, rural and urban development, food and energy
7.	National Committee on Science and Technology (NCST)	1977-1980	Dr. Atma Ram	Sectoral reports on health and family welfare, mining, transport, special materials, waste management
6.	Science Advisory Committee to the Cabinet (SAC-C)	1981-1983	Dr.M.S. Swaminathan	Establishment of national council for S&T, National Biotechnology Board, Technology policy statement (drafting)
7.	Science Advisory Committee to the Cabinet (SAC-C)	1983-1985	Dr. M.G.K. Menon	Technology policy, entrepreneurship, science communication
8.	Science Advisory Council to the Prime Minister (SAC-PM)	1986-1990	Prof. C.N.R. Rao	Setting up of TIFAC, recommendation for the technology policy implementation, technology missions, robotics

9.	SAC-PM Office of Principal Scientific Advisor (PSA) and SAC-C	1991- 1999-2001	A.P.J Kalam Prof. R. Chidambaram	Management of land and water resources, Successful nuclear weapon test, technology development fund
10.	Office of Principal Scientific Advisor (PSA) and SAC-C	2000-2018 2005-2014	Prof. R. Chidambaram Prof. CNR Rao	National Science and Technology Innovation Foundation (NSTIF), Formation of 5 Centre for Policy Research, STI policy 3013, National Nanotechnology Mission, society for Electronic Transaction and Security, Rural Technology Action Group
11.	Office of Principal Scientific Advisor (PSA)	2018-2021	Professor Vijayraghavan	Yet to begin

This shows the past and current setting in which advice on S&T policy decisions takes place in India. Hennen and Nierling (2015) characterise the institutional forms of TA in a more specific way as 'intended not only just to provide insights but to inform political decision-making' (p. 5). TA in a broader sense could be seen as 'providing a link to science and society' (Hennen & Nierling 2015: 5). In India, most of the science advisory role is undertaken by apex bodies constituted by head of the institutions from major scientific organisations. Yet, at various instances, these different apex bodies were reconstituted in order to better align the goal of socio-economic development with S&T programmes by bringing in members from Planning Commission (now this job is done by NITI Aayog) and Ministry of Industries (Sikka 1995b). This alignment of goals of science advice and mandates of other ministries often helps in channelling the direction of science advice to practical issues and questions on national needs.

At the department level, major S&T institutions in India have specific projects, sections and other formal and informal set-up that are dedicated to, institutionally, providing a link between science and society. The Department of Science and Technology, for example, has multiple programmes under the S&T for socio-economic development which majorly engages with the promotion of centre and state level science communication and local entrepreneurship building[4]. Under this programme, the Science for Equity Empowerment and Development (SEED), is said to be developed for ensuring sustainable livelihoods at the grassroots level through technological empowerment[5]. However, the programmes supported under this initiative are either frugal, rural entrepreneurship support or education, information dissemination and training in low-tech jobs. There seems to be a developmental divide in the imagination of S&T in India where high-tech, high investment science is devoted to the urban population and international community; while low-tech, low investment science goes to the rural population. This second-rate treatment of the rural population goes against the welfare and socialistic approaches which were foundational stone of Indian science. It points to an apparent shift in Indian science towards a market economy and investment based on purchasing power. The formulation of S&T policies based on understanding of citizen as consumers might not lead to the goals of social inclusion and all-round development. Similarly, the CSIR has The National Institute for Science Technology and Development (NISTADS) which undertakes research on aspects of science, society, and development. Hennen and Nierling (2015) also point towards the democratic function of TA institutions which involves TA's role as an interface between public and the government. This also includes acting as a facilitator for deliberation of public problems. In the Indian context, as per the current institutional structure, this role of TA is very limited. There are very few occasions in the history of Independent India where public input is on S&T issues is sought from government institutions. As for the active role of TA as an institutional mechanism to inform political decision making, currently NITI Aayog and TIFAC are doing this job in Indian S&T struc-

4 http://www.dst.gov.in/scientific-programmes/st-and-socio-economic-development/science-equity-empowerment-and-development-seed

5 http://www.dst.gov.in/scientific-programmes/st-and-socio-economic-development/science-equity-empowerment-and-development-seed

ture (NITI Aayog 2017; TIFAC 2017). However, most of their advice to government relies on a mainly technocratic, expert-centric understanding of science and society.

Other public and private organisations working on science and society aspects could potentially be considered as TA institutions. The capacity, provided the population and diversity of the country allow for it, to conduct public deliberation and policy analysis on issues that connect science and society is very limited in India. There are excellent organisations that are good in either science aspects or societal aspects, but the recognition of inter-disciplinary interactions is still lacking. For example, there are excellent institutions that work on environmental sustainability issues from a scientific perspective and institutions doing work on labour issues and social justice aspects. But if we consider institutions that would be working on both the issues in the context of policy making for S&T in the context of electronic waste and toxic waste, their number is negligible. However, there are still few public and private organisations that could take on an exceptional role in policy advice to parliament on science and society issue. There seems to be a lack of political will in the uptake of research and policy advice from such institutions by the government. This lack of will stems from the stern criticisms of the S&T based developmental models of the government resulting in a lack of trust and fear that these critics may negatively impact the pace of economic development.

3 Science and Technology Priorities and Values

Mashelkar (2008) describes that the Indian S&T enterprise is led by four major priorities – Techno-nationalism, inclusive growth, techno-globalism and global leadership. These priorities are guided by core values. Techno-nationalism is guided by self-reliance for technologies concerning national security and defence with core competencies in technologies related to space, atomic energy and supercomputers. Inclusive growth is guided by values concern for the local population and equity and access to the benefits of S&T, for example, the pharmaceutical sector. Techno-globalism is guided by the values of international co-operation in areas where India could provide an economic advantage in terms of low-input costs and high skills such as in the IT sector. Techno-leadership is guided by the acquisition of competitive edge in the global market through support and funding for developing innovation ecosystems. The following section will describe how these values and priorities were embedded in national science policies.

Modern S&T played a central role in the democratic imagination and nation-building of post-independence India. However, there were disagreements among the prominent political leaders of that time about the institutionalisation of modern S&T in India and its relation with society (Zachariah 2001; Gandhi 1984; Kumar 2000; Jodhka 2002). While one group, epitomised as Nehruvian science, believed in the big science model, with a top-down, expert-led, centrally-controlled institutional arrangement and heavy investment in R&D and industrialization (Arnold 2013a). The other group, with Gandhian ideals, argued for a decentralised, locally specific, and public-centric model (Gandhi 1984; Vishwanathan 1997; Prasad 2001). The S&T system in India eventually adopted the Nehruvian big science model with some arrangements to incorporate Gandhian ideals as well.

The Nehruvian fascination for modern S&T stems from the role it has played in the development and prosperity of industrialised countries. Promoting the ideals of science and technology as good in themselves and beneficial for the country, Nehru made his thoughts clear in a speech at Indian science congress in 1937. He said that 'science is the spirit of the age and the dominating factor of modern world … the future belongs to science and those who make friends with science and seek its help for the advancement of society' (Nehru 1976). Along with the technocratic approach to re-shape Indian science policy, Nehruvian science could also be attributed to promoting a top-down relationship between science and society. By equating modern laboratories as 'temples of science in the service of motherland' (Arnold 2013b: 368), Nehru actually argued for an unquestionable faith in the modern scientific establishment. Furthering the codes of conduct between science and society, he defined the notion of a good citizen in the modern S&T-led world as those people 'who make friends with science and develop a scientific temper' (Arnold 2013b: 369). Based on this technocratic, centrally controlled and expert-led understanding of the science and society, most of the science policy advice in the Nehruvian era came from practicing scientists and engineers. This started a culture of formal science policy advice in India that involved experts mostly from a scientific and technological background having more stake and experience in the working of science rather than society (Narsimha 2008).

The Gandhian vision of science and society, as described earlier, could be summed up as a relationship of critical discourse and democratic deliberation rather than faithful submission (Visvanathan 1997; Gandhi 1984). For him, rather than accepting modern science and technology as good in itself, it has to be customised and prioritised according to the local, specific needs and priorities (Prasad 2001; Visvanathan 1997; Gandhi 1984). Documenting his vision for post-independence India, Gandhi wrote in *Hind Swaraj* about the need to focus on sustainability, self-reliance, and inclusion of local communities in the S&T led developmental model (Gandhi 1984). For Gandhi, in order to be useful for the local context, S&T should look outside the laboratory for science advice and feedback. This means that rather than looking at the laboratory and university as the unit to understand the relationship of science and society, it would be more useful to consider every village as a science academy and unit of analysis in itself (Visvanathan 1997; Prasad 2001; Gandhi 1984). The Gandhian vision of science and society and policy advice is majorly sidelined in the formal policy-making arena. However, it has a long tradition of being adopted and implemented by public and private organizations who believe in participatory approaches in defining the agenda of science policy advice such as Centre for Sustainable Technologies (IISc), and Peoples' science movement (Raina 1990; Prasad 2001; Rajan 2005).

From the late 1980s, major controversies related to Big Science developmental projects resulted in discontents and disenchantment with Nehruvian models of science-society interaction. Issues of displacement and damage to local communities and ecosystem from large dam projects (Rajan 2005; Guha 1995), social and environmental impacts of agricultural modernization (Shiva 1991; Guha 1995), Bhopal Gas disaster (Fortun 2009; Jasanoff 2007) and risks associated to nuclear power plants, were all followed by the rise of civil society groups and non-governmental organisations in the 1990s. Most of the environmental and developmental NGOs supported a Gandhian approach for science policy and advocated the need of social and environmental impact assessment for science policy advice[6] (Scoones 2006; Guha 1995). This strengthened the demand for participatory approaches of TA in India. India has four S&T policies post-independence till now. The section below will discuss specific national priorities and underlying values that prominently shaped these four science policy resolutions.

3.1 Science policy of 1958: institutionalization of science and promotion of scientific temper

The British Empire in India helped in the establishment of many scientific and training institutions such as the Archaeological Survey of India, The Indian Meteorological, and The Botanical Research Institutes. However, scholars have pointed out that most of these organisations were started to train Indian subordinates to help in the growth and expansion of the colonial empire (Kumar 1997; Prakash 1999). A need was felt by the top leadership and the scientific experts in post-independence India to support institutionalisation and capacity building in basic sciences (Rao 2008; Narasimha 2008). The science policy resolution that came in 1958 'was basically a declaration of faith, promising

[6] The next section engages in more details on pTA in India.

to promote science, educate and train scientists […] and secure for the country the benefits of scientific knowledge' (Narsimha 2008: 336). This led to the establishment and support of many scientific institutions for 30 years and position of scientists as advisors for the government (DST 1958). This public support system developed core competencies of India in the field of space research and atomic research. The Council of Scientific & Industrial Research (CSIR) and Indian Institute of Technology (IITs) were also enormously funded by the state to carry out the mandate of science policy resolution. Science policy advice was mostly given through specific high-level commissions like the atomic energy commission, space and electronics commission constituted mostly by senior scientists, bureaucrats, and politicians (Rao 2008). In those initial years, even representatives from industry were excluded from science policy advice (Narasimha 2008). The relationship between science and society was that of the deficit model where the general public is assumed to be largely ignorant and the role of science is to provide information and raise awareness (Sturgis & Allum 2004). Information dissemination in the form of educational radio and TV programmes in the remote villages through satellite telecast were considered as the major social achievement of the space programme (Narasimha 2008). As per Visvanathan (1985), the institutionalization of science in bureaucratic structures like CISR led to expertise-oriented, hierarchal systems which eventually left no space for democratic discussions and dissent that were once imagined as the core values of S&T system in India by Gandhi.

3.2 Technology policy of 1983: Self-reliance through technological capability

By 1980s, India had faced multiple wars from its immediate neighbours (China and Pakistan) and national security became the central focus for policy making, including science policy. There were instances where the developed world had denied technological support to India (Narasimha 2008) and needed to develop indigenous technological capabilities (not just scientific knowledge) became evident. The sustained support from the state and efforts of doing world-class science also distanced Indian scientists from local realities and vulnerabilities such as the resource constrains and economic instability. This led the Prime minister, Indira Gandhi, to come up with the Technology policy of 1983 which emphasised on self-reliance through technological capabilities and use of indigenous resources (DST 1983). It was argued that the Western models of development and industrialization, adopted quite similarly by Indian counterparts, relied heavily on man-made capital which is measured by GDP centric growth (Gadgil 2014). This obsession with GDP as a measure of development and progress often caused rapid depletion of natural resources, injustices to the human beings and social institutions. This, as emphasised by Stiglitz, ignores the potential of natural, human and social capital in growth and development by promoting corruption and faulty law and order (Stiglitz 2002). A National Committee of Science and Technology (NCST) was created in 1971, which had the sole objective of giving science advice to the government and helping the incorporation of S&T in socio-economic planning (Rao 2008). The advice from NCST resulted in setting up the Department of Science and Technology (DST) and the Science and Engineering Research Council (SERC). Both these organizations became central to the promotion and development of science led initiatives in the country including many mission mode programmes (Rao 2008). The recommendation of NCST, Technology policy 1983 and efforts of SAC-PM eventually led to the establishment of TIFAC in 1988.

3.3 Science and Technology Policy 2003: Towards a Holistic S&T

The most interesting feature of the S&T policy 2003, often pointed out in commentaries and research notes, is the recognition that in order to fulfil the goals of socio-economic developments focus should lie not only on science and scientific temper, but more so on technology development for everyday use (DST 2003, Narasimha 2008). Along with military security, the policy argues for social security of the people through judicious use of S&T (DST 2003) This also implied that for applied research, science and technology had to be thought together rather than the existing neat and separate categories[7]. The policy recognised increasing challenges of globalization, intellectual property rights, brain drain, and social, legal and ethical impacts of S&T (DST 2003). A special emphasis was put on foresight activities that would encourage the development of roadmaps in strategic priority areas. These roadmaps were encouraged to take socio-economic and environmental aspects into consideration along with an assessment of S&T parameters (DST 2003). The policy focussed on building robust national innovation systems to promote the exchange and collaboration between government, academia, and industry (DST 2003). The management and organisation of science largely remained in the hands of scientists and engineers (Roy 2003). Thus, in a top-down manner, it was scientists and experts' responsibility to decide on the socio-economic impacts of science and relation between science and society.

3.4 Science, Technology, and Innovation (STI) Policy 2013: The Twin Goals of Global Economic Competitiveness and Inclusive Development

The STI policy of 2013 comes with an active recognition that despite 50 years of state-funded support to the enterprises of S&T in India, economic reforms in the form of liberalisation, a majority of the population is still excluded from the developmental agenda (DST 2013). Thus, the policy emphasises on 'the discovery and delivery of science-led solutions for faster, sustainable and inclusive growth'[8] (DST 2013: 21). The policy also realises that there is a need to cultivate a culture of risk-taking in the innovation ecosystem of S&T led

[7] https://www.thehindubusinessline.com/2003/01/04/stories/2003010402410500.htm
[8] http://www.dst.gov.in/sites/default/files/STI%20Policy%202013-English.pdf

enterprises. This, it is proposed, could be done through institutional mechanisms of multi-level funding, infrastructure and policy support for entrepreneurs. A fund for innovations for social inclusion and priority areas for resource-constrained settings is proposed to be set-up. R&D prioritisation is planned to be directed in the area of renewable energy, low-cost diagnostics, water, agriculture and health (DST 2013). However, despite these very welcomed steps and novel intention to be inclusive and equitable to all people, the STI policy 2013, again, falls prey to a technocratic, science-expert led understanding, which misses on a number of key features of Indian society (Abrol 2013; Krishna 2013; Sheikh 2014). The emphasis on inclusive growth suggests that the trickle-down effect of economic growth is not working. On the contrary, as Gadgil calls it, we are in the 'suck-up' model of economic growth where a majority of the country is dependent on informal sector and natural resource-based jobs for its livelihood (Gadgil 2014; Sheikh 2014). There is no account of how many jobs in the informal sector are lost due to a lax attitude towards environment destruction through S&T led developmental projects (Abrol 2014; Gadgil 2014). Still, the policy document fails to acknowledge the role of the large informal sector and its contribution to India economy (Sheikh 2014). This means that other than investment in S&T discoveries, an urgent focus on institutional innovations, maintenance mechanisms, and governance infrastructure is required to realise the dream of access and inclusivity (Abrol 2014). For example, India is a world leader in the pharmaceutical and low-cost diagnostics area, but still, these facilities are not available to a majority of rural population because of the lack of focus and investment on institutional and governance mechanisms.

4 Technology Assessment State-of-Art

Grunwald (2018) characterises TA in three main categories based on actors' typology. These are TA as policy advice, TA in public debate and TA in the engineering process. In the Indian case, one more category of TA becomes very crucial which could be termed as TA as critical discourse. The section below discussed each of these categories in details as applicable in the Indian context.

TA as policy advice

Science policy advice (as discussed in sections above) is well developed and institutionalised in India. The primary role of different committees and institutions that are engaged in S&T advice lies in assisting the government in making informed decisions about the future directions of S&T, funding, and supporting innovation ecosystem. However, there are serious criticisms about the inadequate use of science advice by government (Ramachandran 2004) and operation of these committees with regard to lack of transparency in functioning and lax attitude towards consideration of governance aspects (Sekhsaria & Thayyil 2017; Pandey 2013). Scholars have criticised the increased bureaucratization of science through a large number of committees and departments leading to logjams in proper functioning (Ramachandran 2004; Kumar 2000; Sharma 1992). Ramachandran (2004) argues that despite the efforts of different advisory committees to come up with concrete recommendations, many a times, these are not taken into considerations due to the complicated decision making structure of Indian government and mismatch in the S&T priorities and economic, financial and trade policies. Due to the technocratic focus of S&T advice and lack of mechanisms to ensure accountability, reviews, and reports that focus on critical evaluation of past performance in relation to synergy with industries, economic capacity and socio-economic goals, are often not considered (Sharma 1992). There is a very little discussion in the parliament on S&T issues due to lack of capacity of the members and exclusionary nature of science advisory committees to independent organizations and media (Sharma 1992).

TA in public debate

Participatory approaches to TA gained prominence worldwide in the context of global criticisms of technocratic models, discontents of developmental initiatives, technology related controversies and mishaps, environmental issues and rejection of certain big technologies by consumers (Abels and Bora 2006, Durant 1999, Hennen 1999, Grunwald 2011, Zhao et al. 2015). It was felt that, in order to improve the knowledge basis and values foundation on which technology decisions are made, citizens and stakeholders should be involved. By involving a larger spectrum of society with plural and possibility divergent opinions, decisions should become more robust and their legitimacy enhanced (Stirling 2008). In India, the Gandhian vision of S&T always supported context dependent, bottom-up and local-community engagement. However, these visions were mostly marginalized and sometimes re-appropriated by expert-led formal policy making domains. Generally, the large population and diversity are used as an excuse to defy the relevance of such exercises by governmental officials (Fieldwork 2011, 2015, 2017). Recently, owing to India's participation in many global S&T initiatives, participatory approaches to S&T decision making and consultation with relevant stakeholders are made mandatory. Most of the time, in practice, the capacity of these approaches is severely limited to a deficit model understanding of public engagement, where public needs to be informed and made aware of the inherent 'good' of expert-led S&T decisions (Durant 1999). When public opinion is sought, it is often restricted to online surveys and online feedback mechanisms. This mode of engagement excludes a majority of rural Indian population, women, and economically and socially marginalised sections, for instance with no access to the internet for contributing their inputs for S&T issues. India has a very vibrant culture of Civil Society Organization (CSO) working in the developmental sector. Yet, in the majority of instances, the focus of the participatory exercises conducted by CSOs is directed towards developmental and social justice aspects of S&T interventions rather than technology assessment and policy-making (Zhao et al. 2015; Agarwal et al. 2015). The capacity of CSOs to conduct country-level activities is also limited due to the lack of sufficient economic and human resources. There are various examples where many local

CSOs in collaboration with the international organization have successfully conducted participatory technology assessment (pTA) in India (Pimbert & Wakeford 2002; Ely et al. 2015; Pandey et al. 2017b). Despite this capacity and experience of CSOs in this regard, they are often kept out of most of the S&T policy decision-making process (Raina 2010; Pandey 2016). Many times, the CSO recommendations are declared anti-science by scientific establishments because of their regular critique of the way technological interventions are narrowly designed and executed (Zhao et al. 2015; Pandey 2016).

The question of the capacity to conduct pTA activities in India could also be addressed by looking at the large agricultural extension system which was put in place by the government in the 1960s and 70s to promote adoption of agricultural modernisation technologies by farmers (Scoones 2006). The agricultural extension system has thousands of government and semi-government employees and is spread through state and district level nodal agencies to villages. These employees receive regular training from the agricultural councils and universities on promoting the use of new technologies in rural areas. Additional training in pTA could provide excellent mechanisms of rural technology assessment and appraisal. Similarly, in 2010, before the commercial release of first GM food in India-Bt eggplant, the government sought critical inputs from a citizen of 7 states in the country. The review included feedback on scientific as well as social, ethical, legal implications of GMOs. The consultation resulted in an indefinite moratorium on the release of Bt eggplant on the grounds of lack of enough safety evidences. But, it gathered critical acclaims from farmer organisations, civil society, research organisations and academicians worldwide for being an exercise in scientific democracy and democratic governance (Gupta 2011; Pandey 2016). This suggests that there is enough need and scope of pTA in India and it is more a question of scientific and political will than of capacity and resources (Raina 2010; Gupta 2011; Pandey 2016).

TA in the engineering process

This approach to TA responds to the criticisms of linear models of technology development. It ensures that multi-stakeholder feedback goes in during the developmental stage of the technology itself. This would increase the chances of acceptance of a technology in the market as the values and priorities of multiple stakeholders are already incorporated in the design (Schot & Rip 1997). There are different ways through which CTA is practiced and implemented depending on the method and stage of deliberative exercise during technology development. These are real-time TA (Guston & Sarewitz 2002), mid-stream modulation (Fisher et al. 2006), value sensitive design (van der Hoven & Manders-Huits 2009) and upstream engagement (Pidgeon & Rogers-Hayden 2007) to name a few. A consideration of CTA during the technology development phase comes with the underlying assumption that diversity in world-views, when taken into account during the design process, actually enhances the robustness and quality of the finished product. This emphasises that, as part of their curricula, science and engineering students should be trained in practical methods and approaches to engage with their social worlds. In Europe and USA, there are full-fledged, dedicated interdisciplinary courses in engineering departments that train the students in these aspects.

India lacks severely in the institutionalisation of interdisciplinary understanding in academic S&T programmes. Most times, any attempt of introducing courses that reflect on the philosophy and socio-economic aspects of science and engineering, in the curricula is rejected on the grounds of its relevance and lack of funds (Sharma 1992). Instead, these funds are diverted to infrastructure and capacity building for one or more scientific disciplines (Sharma 1992). As a result, the capacity of scientists and engineers to engage with social, ethical, cultural, legal, philosophical and economic aspects of new technologies is severely limited. In traditional institutions such as Indian Institute of Sciences (IISc), for a long time, there was not a single programme to educate the students on aspects of science other than science itself. The interaction of students is mostly restricted to students of other scientific disciplines and confines of the academic space. There was an inherent Brahminical hierarchy[9] in the way, science was organised at such institutions (Visvanathan 2002). The more a discipline is limited to mind, coded knowledge and laboratory space, the more valuable it is. While if the knowledge is developed in relation to practice in the outside world, such as the work of Appropriate Science and Technology for Rural Areas Centre (ASTRA), it is looked down on as inferior within the science hierarchy. The impacts of such inherent hierarchy became apparent during the late 1970s and early 1980s when emphasis was put on the development of indigenous technologies. The subsequent policies (1983, 2003, 2013) strongly emphasised on the development of practical skills and risk-taking capacities in scientists and engineers. In relatively newer institutions such as Indian Institute of Technologies (IITs) and Indian Institute of Science and Educational Research (IISER), it is mandated to have humanities and social science departments. However, most of these departments engage in traditional disciplinary research and severely lack in capacity to engage in interdisciplinary aspects of science and society. The Centre for Studies in Science Policy at Jawaharlal Nehru University, RIS, NISTADS and the recently opened Centre for Science Policy and Innovation at Gujrat Central University are the only places in India which have faculty trained in interdisciplinary science and society studies (including TA). However, most of their work can only be categorised under TA as critical discourse (discussed in the following section) as they lack any interaction with science and engineering institutions. Recently, efforts to develop capacity in interdisciplinary and practical aspects of S&T are being made by the government. This includes setting up of DST-Centre for Policy Research at five institutions all over India and public policy initiatives at IIT-Delhi and IIT-B, Mumbai. The aim of these initiatives is to develop capacities in core areas of science policy related issues[10].

[9] Highest level of the traditional caste system in India.

[10] Link to DST advertisement in Current Science http://www.currentscience.ac.in/Volumes/111/02/0431.pdf

TA as critical discourse

TA in this sense would encompass the rich tradition of academic and non-academic critical discourse that argues for a redefinition of science in relation to society and vice versa (Visvanathan 2002, 2001). There are excellent Marxist, Gandhian and traditional knowledge oriented critiques on the values associated to S&T, techno-centric and expert-led developmental models, considerations of local context such as environment, informality, and inequality (Visvanathan 2002, 1997; Prasad 2001, 2008; Raina 1990; Guha 1995). TA as critical discourse looks at the diversity of knowledges (along with modern scientific knowledge) present in India in relation to different epistemologies and ontologies and argues for knowledge *Swaraj* and cognitive justice (Bijker 2013; Vishvanathan, 1997). Many academic institutions[11] and non-governmental think tanks[12] regularly produce a large number of good quality academic papers, reports and policy briefs on issues related to S&T policy. Despite this, these outputs fail to create any useful connections with the world of formal policy-making (PTA), have a very limited impact as practice on the ground (pTA) and do not communicate to the decisions in the lab (CTA). There are strong elements of lack of trust on such literature by the government organisations because of a techno-centric understanding of science policy and TA in India. Most of the times, the merit of a text related to science policy is judged on the basis of affiliation to government or training in scientific and engineering disciplines. TA as critical discourse needs a separate categorisation in context of India because of the rich content of the discourse and analysis it has generated, and it's potential to impact TA practice on the ground as well as improving reflexivity of science policy decision in the formal circles. A separate categorisation would also encourage possible mechanisms of engagement and interaction between academia, policy-making (PTA) and practice (CTA and pTA).

[11] Such as Centre for Studies in Science Policy in Jawaharlal Nehru University, NISTADS under CSIR

[12] TERI (http://www.teriin.org/), CSE (https://www.cseindia.org/), Toxics Link (http://toxicslink.org/)

On the basis of the above discussion, it becomes apparent that TA activities in India exist in a fragmented and unstructured manner. There are different actors that engage with and contribute to TA exercises in different formats. If we consider the TA matrix, there is no single agency or organisation that could be held responsible for carrying out all these activities. In addition to government programmes, technology assessment and foresight is also conducted in the private sector. Against the commonly held view, that Technology Assessment and Technology Foresight (TATF) is conducted more in the large-scale units, even the small and medium enterprises conduct some kind of TATF exercises. A study of the Indian biotechnology sector revealed that sub-sectors such as pharmaceutical biotech pay more attention to foresight compared to industrial biotech and agriculture biotech. While the preference was absolutely visible for national-level foresight compared to regional or international levels. In industry, the focus of TA is more oriented towards quantitative expert centric and innovation oriented assessments. Brainstorming, Risk Analysis, Literature Review, SWOT[13] Analysis and Expert Panel, were chosen as the important methods of foresight rather than more sophisticated methods such as Scenario Planning, Growth Curves and Analytical Models. Issues like profit maximization, marketing, cost reduction and enhancing the functional capability of the products appear to be the major expected output from the foresight exercise (Desai, 2014).

Most of the TA activities conducted by government or government agencies (such as TIFAC) are top-down, technocratic and expert-oriented. The involvement of public is minimal and mostly limited to giving feedback on drafts of policies or initiatives through online citizen portals. So, involvement of public on the level of agenda setting for new technological interventions is a rare occurrence as well as the process of evaluation of policies through public debate and seeking democratic legitimisation. The only example that stands out with regard to societal aspects and forming opinions and attitudes is the Bt

[13] Strength, Weakness, Opportunities and Threats (SWOT) analysis is a popular form of technology assessment

Brinjal public consultations sought by the government in 2010. The consultations, on the basis on meetings with different stakeholders in 7 states of India, brought out multiple scientific, socio-economic and environmental reasons that resulted in the moratorium on this GM crop in India. This event was severely criticised as negatively impacting science by the scientific community and technocracy in India and no such exercise was deemed as important or conducted after that. The lack of public engagement in technological decisions results from the deficit model understanding of the 'pubic' as ignorant and 'expertise' resulting from formal training only. Organisations such as TIFAC as well as engineering institutes lack severely in trained interdisciplinary researchers that can engage meaningfully with social, cultural, political and ethical aspects of technology. This makes TA, when conducted by these organisations, mostly a technocratic and bureaucratic tick-mark exercise. This results in lack of innovative ideas, plans and mechanisms for the re-assessment and implementation of technologies and policies. This lack of innovativeness is a continuous cause of concern among policy-makers. However, the techno-centric understanding that considers governance measures as inhibitory for developmental objectives, limit any attempt towards experimental and exploratory approaches for TA. There is a growing recognition that new ways of engaging with S&T policy are required to encourage inclusivity and equity. This opens-up spaces and opportunities for the future roles of TA for India. TA could play the role of 'facilitator' in easing out the problematic relationship between innovation and governance. This could be done through setting-up independent, interdisciplinary platforms for TA that could engage in regular exercises to promote trust-building and accountability.

5 Indian Perspectives for a Global Technology Assessment

In the contemporary world context, there are many pressing challenges like climate change that demand a global and collective engagement. Similarly, the unknown, ambiguous and uncertain impacts of many emerging technologies (Stirling 2008) such as artificial intelligence, synthetic biology, and nanotechnology, require collaborative efforts in Responsible Research and Innovation (Owen et al. 2012; Grunwald 2011) as well as anticipatory governance (Guston 2014). A global TA could be a very useful resource in such a situation. However, it is important that the framework of this exercise takes into consideration the fragmented and diverse nature of multiple localities that collectively form the local, regional, national and global context. For countries like India, two issues are central in engaging with global TA. One is the capacity in terms of trained human resource to engage in such activities, and other is the political will to sponsor the capacity building. Both these questions could be, to some extent, addressed as a result of being part of a networked approach such as global TA (Ely et al. 2015).

India has many strategic S&T collaborations with different countries of the world. These multi-country collaborations are guided by different priorities of the Indian S&T system (techno-nationalism, inclusive development, techno-globalism and global-leadership). For example, the BRICS network is more focussed on aspects of inclusive development and techno-leadership[14]. While, the Indo-French and Indo-German[15] collaborations are more focussed on developing knowledge, industrial relations and knowledge networks in a globalising world. On the one hand, techno-nationalism and inclusive development are based on internal, socio-cultural priorities. On the other, techno-global-

[14] https://www.brics2017.org/English/AboutBRICS/BRICS/

[15] Indo-France co-operation http://www.cefipra.org/, Indo-German co-operation http://www.igstc.org/

ism and global-leadership are outwardly oriented towards global competitiveness. Despite these clear demarcation of priorities, formal S&T mechanisms often ignore certain aspects of the Indian society that would impact global S&T collaborations and must be incorporated in any consideration of global TA. First, a majority of R&D funding and initiatives still come from the government with the private sector playing a very small role (Rao 2008). The government regularly comes up with schemes and programmes that support scientists to set-up S&T enterprises. However, a comprehensive analysis of the distance between academia and industry is still missing. Second, the informal sector in India is huge. This provides it with multiple opportunities in terms of meeting needs of a large number of population which is below-the-radar of the formal set-up. The challenges of such a system are the lack of implementation of standards, regulations and governance mechanisms. The informal sector is regularly being studied for its innovative potential in the context of frugality and resource-constrains. However, there are seldom any studies that take into account the environmental and social justice challenges posed by the huge informality in the country. Third, any exercise of global TA should take in to account the presence of huge diversity in India in terms of cultures, ethnic groups, and values. This would mean developing capacities in terms of human resources, intermediary organisations and communication channels that are sensitive to these aspects. At the same time, the capacity to translate these sensitivities into actionable global agendas is needed. For example, in the context of discussions on global TA about the bio-based economy, there is a need to consider the values that farmers associate to locally available forest resources which formal S&T systems and industry often categorise as ‘waste' or agri/forest residue (Pandey et al. 2017 a, b). Similarly, while considering fallow government land for growing energy crops, inclusion of local communities’ usage for that land (Baka 2014) would enhance the function of global TA. Fourth, the myth of access and inclusion through the support of S&T should be carefully considered in global TA programmes when engaging with countries such as India. Rather than too much focus on product and process innovation for S&T, investment is required on institutional innovations which consider mechanisms of maintenance, regulation, and governance.

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Technology Assessment in Russia

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1 Basic Information on Russia and its History with TA

Russia is a presidential-parliamentary republic with a federal structure[1]. The Russian Federation comprises eighty-five equal Subjects of the federation (region or oblast). Each region has a legislative body (legislative assembly – Duma) and an executive body (government). In all Subjects, there is a post of the highest officials – the head or the governor. The Russian Federation is also divided into eight federal districts, each of which has an authorised representative of the President of Russia. The Subjects of the federation have their own administrative-territorial division. The main administrative-territorial units within the constituent entity of the federation are the regions and cities of regional (republican, regional, and district) significance.

Russia is the largest country in the world by area. The territory of Russia is 17,125,191 square kilometres. As of January of 2018, the population of Russia is 146,877,088, including 109.032.400 people living in urban areas and 37,772,000 people identified as rural population. The life expectancy in 2016 was 71.87 years. Even though the average life expectancy is increasing, there is a decrease in the natural growth of the population. So, in 2016 there was

[1] http://www.gov.ru/main/konst/konst0.html (in Russian)

an actual decrease of the population by 2,286 individuals. A particularly strong growth decline occurs in the rural population (Rosstat 2017: 263).

The level of literacy in Russia is traditionally quite high. According to the results of a study in 2016, 99.4% of the population age 15 and older has reading and writing skills[2] whereas 27,3% of population age 25-65 has a higher education degree (Gokhberg 2016). Moreover, the current state policy is directed towards the development of the science and innovations policies. Since 2000, there has been a steady increase in the governmental funding of S&T. Compared to the year 2000, the funding of fundamental and applied research in 2016 has increased tremendously[3]. According to official statistics, Gross Domestic Product per capita has also increased. For example, the GDP in market prices in 2014 was 79,199,658 million Rubles, in 2015 it increased to 83,387,191 million Rubles, while in 2016 it reached a total of 86.148,800.0 million Rubles[4].

In order to understand how TA can be developed in Russia more effectively, the country's historical and cultural aspects should be properly explored. In fact, these aspects are deeply influenced by the heritage of the Soviet system, in particular in the area of Science and Technology (S&T) policy. The main feature of the Soviet S&T policy was a strict technocratic approach. This rationality of technology and society management, even though usually deformed by ideology, was very prominent, as was evident in the technocratic planned economy. There was nevertheless one contradiction in this approach; the decision-making power was not held by technocratic engineers, but by technocratic party ideologists. It was the latter who formed the tasks and priorities of the S&T developments in the country. Although the technocratic elite was

2 https://www.metronews.ru/partners/novosti-partnerov-55/reviews/uroven-gramotnosti-v-rossii-na-2016-god-1196188/ (in Russian)

3 http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/science_and_innovations/science/# (in Russian)

4 http://www.gks.ru/free_doc/new_site/vvp/vvp-god/tab1.htm (in Russian)

also invited to share power in the system, they were expected to play a secondary role. The full authority was indeed held by the leaders of the communist party.

With the collapse of USSR (in 1991) the Communist Party lost its prominent position hence, not only the political system and economy of the country broke down, but its S&T structures as well. At the same time, the technocratic elite couldn't take over control of S&T policy due to the lack of political experience. As a result, the scientific and technical output of Russia decreased immensely (Openkin 1990: 256). The analysis of the scientific publications of the 1990s allows us to make some additional observations. In the last years of the Soviet era, a discussion about the excessive technocracy in the field of S&T was initiated. It raised the issue that in the USSR the meaning of technological development was overestimated while the human factor in it was underestimated; this created a gap between the technical and social development in the country (Artemov 1990: 11). As a result, in the 1970s USSR, there was no progress in the field of development of knowledge-intensive industries such as energy. Environmental and social factors were not taken into consideration when designing the strategies of scientific and technical development.

In addition, one important reason of such an excessive technocratic attitude was the country’s reliance on the defence industry. The problems of military build-up, including the design of the newest military equipment and machinery, were always USSR's overriding priority. By the beginning of the 1970s, it had already resulted in the creation of a powerful defence industry complex. In fact, one could argue that this was the foundation of the country's economy. The branches of the military-industrial complex were not only provided with priority financing but also with unlimited material and technical supplies. Special attention was also paid to personnel training. Despite this, it would be wrong to argue that the problem of S&T responsibility wasn't discussed at all during Soviet times. At least in the scientific community, many scientists realised the need to reduce the strong technocratic approach. For instance, Vitalij Gorokhov in his book “To know in order to do: The history of the profession of an engineer and its role in the modern world" explored the issue of the transformation of engineering education to include social aspects (1987: 164-170). Later on, it was Gorokhov who initiated the German-Russian relations in the field of TA[5]. Overall, the heritage of the Soviet technocracy is still both a driver (e.g. increase in modern scientific management) and a barrier in establishing the new paradigm of responsible innovation and the incorporation of TA in it. This issue is still debated intensely in the country.

Today Russia is facing new intellectual and social challenges. This is particularly noticeable because of the decreasing possibilities for the development of the old model, in which S&T development plays a subordinate role within the framework of the "energy-resource" based economic growth, supported by oil revenues. Also demographic issues (low birth rate, high mortality, ageing of the population) are affecting the Russian economy. And in addition, Russia resides in questionable geopolitical conditions. In this regard, the development of an effective S&T policy has become a priority for Russia.

2 Science and Technology Policy Structure in Russia

Since TA is a new practice in the Russian Federation, we can hardly expect to find institutionalised TA elements. We therefore provide a S&T Policy Structure (Fig.1) to be able to indicate points of growth for TA institutionalisation. The structure shows the relationship of the main elements involved in the regulation of the scientific and technical sphere in Russia. The main role in the management of science, technology, and innovation belongs to the State. At the Federal level, the S&T Policy is administered by the President, the government, and the Federal Assembly.

[5] http://www.itas.kit.edu/2016_045.php

The President establishes councils and working groups that carry out deliberative functions in S&T under his supervision. The Government of the Russian Federation represents the executive power in this structure. In the field of S&T, the main ministries are the Ministry of Education and Science, the Ministry of Industry and Trade, and the Ministry of Economic Development. The Federal Assembly represents the legislature in the structure. The Federal Council oversees all processes of S&T regulation, in particular the Analytical Department of the Russian Council of the Federation. The Analytical Department is an associate member of the European Parliamentary Technology Assessment network (EPTA). In fact, it is the only institutionalised element in the structure with TA functions (marked with a sign *) and thus, its functions will be described further in this chapter. The regional level of S&T regulation is represented by regional bodies, although it is decisions at the state level that define policies in the fields of innovation, science, and research in Russia. It is also at state level that the roles and functions of S&T mediators (i.e. development institutions, S&T infrastructure) are decided.

Furthermore, S&T management is carried out within universities, as well as in the Russian Academy of Sciences on the federal level. Regional branches of the Russian Academy of Sciences, regional research institutes and scientific centres are also involved in the S&T administration on the regional level. The development institutions are mainly represented by financial institutions that fund research and innovation projects. Representatives of some organisations are also found in the regions, for example, branches of State Corporation (RosTec, RosAtom, RusNano), Agency for Strategic Initiatives, and Bortnik Foundation.

The S&T infrastructure is represented by various industrial parks, business incubators, TechnoParks, etc. The technological platforms (marked with sign **) are of particular interest for TA. They function as communication platforms for business, science, consumers and the state on the issues of modernisation as well as S&T development in key technological areas.

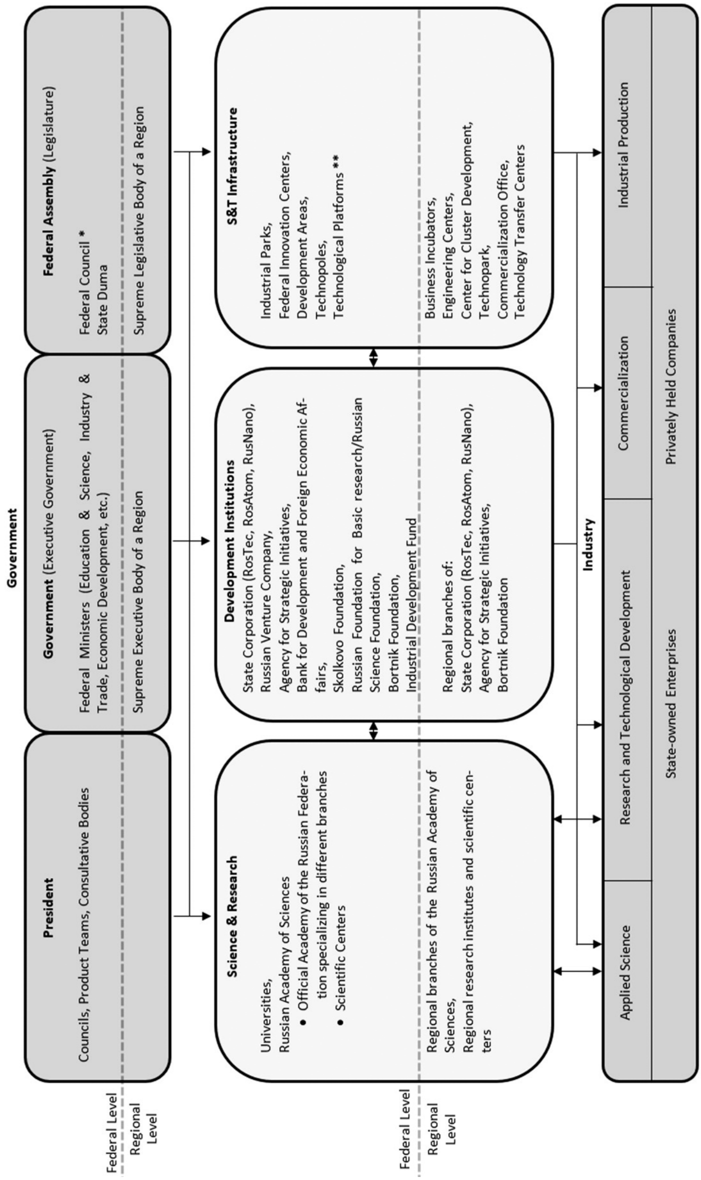

Figure 1: S&T Policy Structure in Russia (Developed by E.N. Akerman, Y.S. Burets)

Currently, there are more than twenty technological platforms dedicated to medicine, bio-resources, information technologies, space industry, etc.

S&T policy in Russia is regulated by a large number of legal acts. The main act is the Federal Law of the Russian Federation "On Science and State Science and Technology Policy" of August 23, 1996 (new version of the law: May 23, 2016). More recently, in 2017, a public debate was initiated on a new draft of the Federal Law "On scientific, technical and innovative activities in the Russian Federation".

At present, the core of the Russian S&T policy is reflected in the program "The National Technology Initiative (NTI)"[6] developed by the Agency for Strategic Initiative (Fig.1). NTI is a long-term strategy for technological development in Russia. Addressed to the Federal Assembly on December 4, 2014, the Russian President Vladimir Putin outlined the National Technological Initiative as one of the main priorities of state policy. NTI unites technological entrepreneurs, representatives of universities and research centres, large business associations, development institutions, expert and professional communities, as well as executive bodies. According to the NTI strategy, the total consumption of science and technology will reach 4% of the GDP by 2035. The earnings of Russian companies and universities from the intellectual products will be 1% of the world market turnover, and Russia will be included into the top 5 countries in terms of the number of professionals engaged in research and development.

Although the Russian model of transformation in S&T policy is influenced by German analogies as well as the European Union's "Horizon 2020" research funding programme, analysis of Russian S&T documents shows that inadequate attention is given to the social and ethical aspects of innovative development. Technological and financially pragmatic functions are always in the emphasis and social expertise is not taken into consideration. This is due to

[6] https://asi.ru/eng/nti/

the fact that Russian TA is still developing under the conditions of strong technocracy that applies to both technical education and S&T policy. Similarly, technocracy is also prominent in analytical documents and NTI roadmaps. Thus, in the NTI concept strategy "The Future Image: Russia as a Pole of Development" (2016)[7], social tasks are mainly reduced to the reformation of technical education and the formation of a "new innovation class" NTI agents. It is necessary to indicate that at this stage of development, we can hardly speak about any serious TA influence on the scientific and technological policy of Russia.

Until recently, TA in Russia was mainly developed in the academic philosophical space. Problems of TA were considered on a theoretical level without any reference to actual S&T practices. Another important weakness of the Russian TA model is the loose connection with the government and national politics concerning the shaping of technology. However, in recent years, we have also witnessed a positive trend. A closer contact has started to develop between promoters of TA and engineers in the country. The Polytechnic universities of Tomsk and Perm have become the main "change agents" in this trend. Also, some Russian researchers from the Agency for Strategic Initiative have started to promote ideas of social responsibility. For example, Ilya Klabukov, a scientist in the field of biotechnology and one of the members of the HealthNet, has established a Responsible Research and Innovation group at NTI.

3 Science and Technology Priorities and Values

Strategic priorities in S&T development in Russia are stated in several basic national documents that form the foundation of the national S&T policies in the country. They are deeply influential in collaborative activities in all S&T

[7] http://docplayer.ru/36967162-Obraz-budushchego-rossiya-kak-polyus-razvitiya.html (in Russian)

areas and also reflect the basic values of the Russian Federation. We can highlight the following basic documents:

- "The Strategy of Scientific and Technological Development of the Russian Federation" from 2016;[8]
- The State program "Science and Technology Development" for years 2013-2020 approved in 2012;[9]
- The State program "Education Development" for years 2013-2020 approved in 2012;[10]
- And the "Long-term Program of Basic research in the Russian Federation" for years 2013-2020 approved in 2012[11].

These documents regulate the work of the Ministry of Education and Science, as well as research and educational organisations, scientists, academicians, researchers, etc. In addition, these documents perform several functions in the regulation of S&T. *Firstly*, the documents determine the priority directions of S&T development. For example, they establish the key fields in S&T to receive support from the state. *Secondly*, they form the state (governmental) 'order' for trends in research and technologies. For example, with the beginning of the Arctic territory development, many unique technical problems emerged including issues of safe oil production, development of a special construction platform, transportation and storage in specific conditions, etc. In order to encourage specialists to solve these problems, the complex development of the Arctic has been declared a priority area for technological research. Thus, the attention of specialists in many areas (scientists, researchers, engineers) was drawn to this particular field. *Thirdly*, these documents describe and explain TA-relevant principles, which are new for Russia but are becoming increasingly important in today's environment.

8 http://sntr-rf.ru/media/Strategy%20STD%20RF(eng).pdf; http://docs.cntd.ru/document/420384257 (in Russian)
9 http://government.ru/en/docs/3346/
10 http://government.ru/en/docs/3342/
11 http://docs.cntd.ru/document/902389469 (in Russian)

We highlight here the main *priorities* of S&T development, which are indicated in the above documents:

1. Sustainable development

All the documents (in particular "the Strategy of Scientific and Technological Development of the Russian Federation") emphasise the need for maintaining sustainability in innovative development. Sustainable development implies both technological and socio-economic aspects. Technical aspects of sustainable development include the transition to digital, intellectual and robotic technologies, as well as a shift to clean and resource efficient electric power. Socio-economic aspects of sustainable development include the transition to adaptive and personalized medicine and a focus on safe and high-quality foods.

2. Risk assessment

It is the priority to assess risks that potentially emerge in the process of scientific and technological development and potential risks of technology use before they occur. For example, documents contain a list of grand challenges that characterise the most critical issues, threats, and opportunities that affect an individual, society, and the country as a whole. Besides stating the necessity of risk forecasting, documents suggest to consider the world tendencies in the development of science and technology assessment. Another priority is to support the improvement of the quality of risks and technology expertise in the area of scientific, technical and socio-economic decision-making.

3. Ethical evaluation of technologies

The documents call for an analysis of changes in social, economic and political relations that are taking place in time of active technological development. Particular attention is paid to the development of Nature-Like Technology, as well as climate and ecosystem management.

4. Openness of the scientific and technological system

The achievement of this goal is ensured by the creation of effective communication between all participants of scientific and technological development. "The Strategy of Scientific and Technological Development of the Russian Federation" establishes the need for creating a link between science, technology, and innovation, in order to increase the acceptance of innovations by the economy and society. In other words, an open interaction of scientific and research organisations with the business community, society, government, and global community is implied.

5. Independent evaluation

The requirement of transparent assessment of the plausible technical solutions with the potential involvement of international specialists is indicated in the "Long-term Program of Basic research in the Russian Federation".

The above-mentioned priorities of S&T development in Russia are not only indicated in the main State documents but they are also obligatory for all stakeholders: State, funds, business, scientific organisations, individual scientists, and researchers. These priorities are closely related to the basic moral values of the Russian Federation. In accordance with the "The Strategy for the Development of Upbringing in the Russian Federation for the Period up to 2025" the established values are: (1) Humanity, (2) justice, (3) personal dignity, (4) motivation for the fulfilment of moral duty for one's sake, family, and nation, (5) honour, (6) integrity, (7) will and (8) faith in good[12].

(1) Humanity or respect for a person, means recognition of the feelings, virtues and personal qualities of another person. Respect as a value, should not depend on the financial state, age, sex, religion, etc. of the individual. Respect for the individual advocates to cause no intentional harm to another person, neither physical nor moral. Respect for the person forms a common basis for the strategy of S&T development in Russia. All of the strategic directions of S&T development are related to respect for people. For example, the social

[12] https://rg.ru/2015/06/08/vospitanie-dok.html (in Russian)

component of sustainable development is the minimisation of material, moral and other imbalances between social groups arising in the process of evolution of nature and society. The main goal is development and functioning of a society in which the vital interests and rights of the majority of citizens coincide and reach an agreement (Shelekhov 2002: 161). Risk assessment and forecasting, which has been identified as a second priority for development, is designed to prevent the negative impact of technology on people or to develop ways to reduce this negative impact. Ethical assessment of technical solution, its openness, and independent evaluation are also aimed at preventing possible harm to a person or their living environment.

(2) Justice is understood differently in every culture. According to Rawls (1971), there are two basic principles of fairness: Firstly, each person is to have an equal right to the most extensive basic liberty compatible with a similar liberty for others. Secondly, consistent with the just savings principle (the difference principle), inequalities are to be arranged in a way that everyone benefits and that the arranging offices and positions are open to everyone regardless of the socio-economical background. Aristotle differentiates between types of justice (Johnston 2011): Distributive justice exhibited in distributions of honours, property, or anything else which is divided among the members of the community. For in such matters men may receive shares that are either equal or unequal to the shares of others. And corrective justice, which Aristotle introduces by saying, immediately after he completes his discussion of distributive justice, “the other kind of justice is the corrective kind” (Johnston 2011: 72). In Russia, justice is usually understood as a concordance between what has been done and what has been received. For example, the concordance of rights and duties of work amount and compensation level. Fairness in this sense is not reflected in the priorities of S&T development, but it is indirectly connected with the requirement of openness of the scientific results and independent evaluation. The relationship between the S&T system (priority) and fairness (value) is manifested in the need for honest and open communication between the participants of the scientific and techno-

logical spheres. Quite often society decides to adopt or not to adopt a technology, based on the assessment of 'fairness' of this technology. For example, if the technology was developed with a lot of resources involved (time, specialists and even finances), it is perceived as more reliable (fair). An independent assessment (priority) is perceived by society as more equitable (value). Thus, if the technology is assessed by an independent expert or by an independent methodology, people tend to trust it to a greater extent.

(3) Personal dignity as the value and right of any citizen is not only stated in the Development of Upbringing Strategy, but also in the Constitution of the Russian Federation[13]. According to this basic law, personal dignity is recognised for each person. The pragmatic aspect of the notion of 'personal dignity' is that it applies to the provision of a certain social level (quality) and the living conditions of an individual person. In other words, the public notion of the value of personal dignity is more connected with the desire to provide a 'standard of living', soliciting only with the material characteristics of a 'dignified life'. This pragmatic form rests on the assessment of most technical solutions in Russia. This value has a stable connection with the priority assessment of risks arising in the process of S&T development.

(4) Motivation for the fulfilment of a moral duty for one's sake, family, and the Nation implies execution of moral obligations of the person for society. The higher the sense of personal responsibility, the more moral the society as a whole is. In general, a person should be humane and observe the norms of reasonable co-existence: be polite, punctual, hardworking, careful and caring towards the relatives and those in need for attention (Hegel 1973: 382). These values, along with honour, integrity, will, and belief in good, constitute an ethical evaluation of technical solutions and contribute to the openness of the scientific and technical system. For example, the aspiration to perform

[13] Constitution of Russian Federation, Section 21 http://constitutionrf.ru/rzd-1/gl-2/st-21-krf (in Russian)

the moral duty by scientists and researchers, allows carrying out the initial ethical assessment of the proposed decision.

The intersection of the stated priorities of the scientific and technological development in Russia and the values that underlie these priorities can be presented in the form of a graph (Fig. 2).

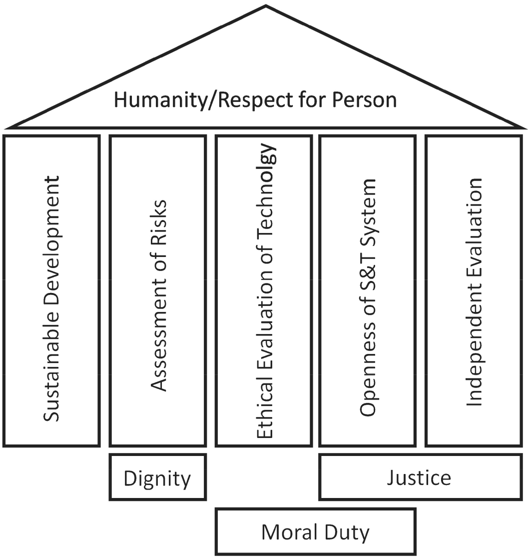

Figure 2: Linkage between S&T priorities and values

From this graph, it is visible that the approved priorities of science and technologies development have stable connections with moral and spiritual values existing in Russia. It should be noted that the debate or public discussion is not accidentally missing in this graph. In some cases, debates or public discussions are the basis for the priorities formation. This situation relates to the fact that debates in the field of S&T in Russia have distinctive features. And these features 'exclude' them from the link of 'value – priorities'.

The *first* feature is the lack of wide public debates on S&T topics. The overall population is practically not involved in discussions on S&T in Russia (see also section Roles of TA in this chapter). The *second* feature of the debate in Russia is the participants of these debates. The main discussions take place in the community of scientists and specialists, often without the involvement of representatives of authorities or the public. It is important to note that these discussions are mostly not interdisciplinary in nature. The range of participants in the scientific and technical debate is limited to experts of a particular field, without actual participation of representatives from other fields or from Civil Society Organisations. For example, robotics technologies are being discussed only by engineers, programmers, and cybernetics, while debates in this field remain completely closed to philosophers, psychologists, sociologists, lawyers and other professionals. The result of this division is an exceptionally mechanistic assessment of technology without serious consideration of the impact of this technology on the individual and society as a whole (see also discussion below on constructive TA).

The *third* feature of the debate is the lack of the alternative initiators. The initiatives of debates in science and technology can be either public or governmental. In Russia, the public does not initiate and practically does not participate in discussions on questions of future technological developments. As pointed out above, there are legal mechanisms in Russia on how to initiate public hearings, but these are not related to S&T. For example, the basis for organising public debates is the federal law[14]. This law defines the issues that should be put to public debate, but none among them could be related to the assessment of science, technology and innovation. As such, the main 'locations of growth' in Russian debates are universities. The National Research Tomsk Polytechnic University (TPU) and Perm National Research Polytechnic University (PNRPU) were among the first who raised the prospects of TA in Russia, by trying to initiate discussions in the field of S&T. However, these

[14] Federal Law "On the general principles of the organisation of local self-government in the Russian Federation", Section 28 http://www.consultant.ru/document/cons_doc_LAW_44571/ (in Russian)

institutions do not have adequate resources to organise Russian-wide debates. As a result, alternative routes are sought, such as a crowdsourcing platform that was launched by the TPU research group[15]. This platform is a virtual space for discussion of the shaping of the comfortable living environment in Tomsk. Participants are invited to leave their opinion on a number of issues, including the shaping of a barrier-free environment for people with disabilities, elderly people, people with children, 'smart' development of students' campus, achieving sustainability of the urban environment in terms of ecology, convenience and comfort.

4 TA State-of-Art: Methodologies and Impact

4.1 Technology Assessment Typology

In exploring the subject of TA in Russia, our team expects that the results will be significantly different from those of other European countries. Following are the main reasons for these differences that are to be found in all three elements of the TA typology (parliamentary TA, participatory TA, and constructive TA).

Firstly, the overall political structure is to be named. During several decades of the twentieth century the USSR policies formed a special form of government-society relationship within Russian society. This relationship still imposes the functions in interactions between S&T, society and politics in modern Russia. It is evident that significant changes in power structures are difficult to achieve in such a short time. And secondly, collective responsibility is a factor. The tradition of collective responsibility or lack of personal respon-

[15] Tomsk 7.0. technology and creativity http://tomsk.tpu.ru/ (in Russian)

sibility, and the habit of avoiding important individual decisions are the remnants of centrally structured economies and strong top-down policies. The outcome is paternalism and a high level of trust in authorities, political leaders, scientists, people with specialised knowledge and strong influence. Also, this is a remnant of the previous system. These reasons show in the different TA types and should help to understand the differences in the formation of TA in Russia.

Parliamentary TA

We will start by describing the body of the parliamentary TA in Russia. It is represented by the Analytical Department of the Russian Council of the Federation. The Council of the Federation is the upper chamber of the Federal Assembly – the Parliament of the Russian Federation. It is formed with representatives of legislative and executive bodies of state authority of the Russian regions. The Analytical Department was established in 1994 as a way to support the legislation process for the upper Chamber of the Federal Assembly. Initially, the primary goal of the Department was to promote the prognosis of social and economic development in society, based on the analysis of the application of the Federal laws[16]. Further development of the activities included preparing legislative drafts, and expert, informational prognostic work on societal development[17]. The reports and information about the Department reveal that its activity was far from Parliamentary TA as it was understood in Europe. In 2015 nonetheless, the Analytical Department of the Russian Council of the Federation became an Associate Member of EPTA[18]. One of the key reasons for the increased interest in technology and innovation in general and TA in particular, is “The Strategy of Scientific and Technological Development of the Russian Federation” from 2016 mentioned above. New goals required a new political initiative. We will use the model described in the report “TA

[16] http://council.gov.ru/events/news/20075/ (in Russian)
[17] http://council.gov.ru/en/committees/
[18] http://www.eptanetwork.org/members/associate-members/russia

Practice in Europe"[19] to describe the characteristics of the parliamentary TA in Russia.

Task/Who is the client

The Analytical Department is part of the Russian Parliament. Initially and still, the government and the parliament itself are its main clients who set its tasks. The Analytical Department provides guidelines to the parliament and the government alike. It is important to emphasise that the Analytical Department has TA as a supplementary function and sees TA in the general development context. The wider public currently could not be called a client of this type of TA. Public involvement is not depicted in the Department's goals or in its functions.

Institution setting/linkage

The Analytical Department is a parliamentary office, which is directly linked to parliament and government. It also has a connection with academia, but the influence of scientists, researchers, and academician experts is not clearly described in Department's functions and cannot be found in the Department's reports.

Who sponsors TA?

As a part of the Russian Council of the Federation, the Analytical Department is sponsored by the government. Important to note here is that separate TA activates could be found at industrial enterprises as part of the Sustainable Development practice. Normally, these types of TA are self-sponsored and have no direct connection with parliamentary TA.

In Russia, we see that TA functions were transferred to the Analytical Department in addition to the main functions performed by it. There are no wide activities in TA, but the relevant fields of research in which the Department is

[19] http://www.pacitaproject.eu/wp-content/uploads/2013/01/TA-Practices-in-Europe-final.pdf

working, have been allocated. The Department's reports show several key areas that can be identified for TA work:

- Ecology and industry;
- Climate change;
- Technology and labour markets;
- And analysis of European application experience of TA.

The Department itself cooperates with scientists and it is headed by a person with a science degree, but as mentioned above, the function of the parliamentary TA in Russia is far from that traditionally understood in most countries. So far, we have not found evidence of attempts to build a broad public dialogue or open interaction with the scientific community on a permanent and transparent basis.

Participatory TA

The peculiarity of participatory TA in Russia is the low activity of citizens in the initiation of discussions and debates and high trust in decision-makers. Attempts to involve citizens and stakeholders in public debates and discussions by scientists and the government have nevertheless been made (Leichteris 2015). Russia is still living in a frame of technological positivism, as indicated earlier. In most cases, technology and innovations are seeing as positive, life-improving forces, and forward going elements of society. To understand how participatory TA works in Russia, it is important to understand the stakeholders of technology: citizens, government, and scientists. In the beginning of the chapter, we highlighted the basic issues that differentiate Russian TA (political structure and lack of individual responsibility). When TA started in the US and Europe, Russia was a country with a centrally planned economy and a very particular view towards technological advancement. If we go back in time, we will see how the political regiment had influenced the relationship between the key players in TA.

1. *Citizens-scientists'* relations: People in Russia have always had trust in science and in the benefit of technologies. The past USSR was built on the

basis of technological competition and on technological success. The USSR was the first country with a man in space and it was a source of pride for its people for years. Important to note is, that even after the Chernobyl disaster people never actively raised questions about ceasing the use of atomic energy. Scientists and innovators have always been a special group, seen as heroes who make contributions to the country's success. No one could dispute the authority of these country heroes that was reflected in Russian mass culture artefacts[20]. This ultimate trust in scientists and technological progress is still persisting in Russian citizens' consciousness. For example, we performed research among students in Tomsk Polytechnic University in February 2017 and discovered technology positivism amongst 100% (out of 130 students) of Russian speaking students represented in the research group.

2. *Citizens-government* relations: The USSR approach to the decision-making, including technological and innovative development decisions, has brought up generations of people who asked very few questions about the technologies being used, research funding, access to the new technologies, safety etc. As a matter of fact, this effect of a paternalistic system is to be found in Russia hundreds of years before the time of the USSR (Kessler & Wong-MingJi 2009). This might as well explain the low activity of Russian citizens in general decision-making, as well as in important technological decision-making. This "delegation" of participatory rights also has a reverse effect: if you do not have the right to choose, then you have no responsibility for the result whatsoever. This lack of individual responsibility is also contributing to the low decision-making initiative (Leichteris 2015).

It is vital to note that it has been more than sixteen years since the USSR collapsed and many new challenges are here to stay. This is evident in many aspects. Citizens have started to realize that they have the right to choose the

[20] Depicted in the movie Nine Days in One Year from 1962 directed by Mikhail Romm. https://en.wikipedia.org/wiki/Nine_Days_in_One_Year

future for the country and that they can shape the world they wish to live in. Current initiatives of citizens are mostly related to urban technologies, such as opportunities people wish to use for shaping the city. Online crowd-sourcing platforms where citizens can decide on the technologies used in their cities, are a usual practice now. Moreover, scientists are gradually discovering the benefits of working closely with stakeholders. But still, we have to admit that initiatives among citizens remain quite low. These first attempts towards participatory TA are just the beginning of a long way and require first and foremost education for all parties. Based on the current development strategy, technology assessment and active public engagement will be among the priorities of innovation development in the Russian Federation. But we may still face the situation that the key players in these initiatives will not have enough knowledge to make the process work as expected.

Constructive TA

Any research on an international scale stumbles firstly on the issue of terminology. Differences in understanding lead to a distortion of the general information picture. Scientists and innovators as the creators of the problem field (technology) should see TA as a tool that makes the technology safer, more comprehensible, and more accessible. Considering the peculiarities of the development of TA in Russia we can hardly expect that the key players have this perception. Based on our reasoning, we conclude that scientists in Russia traditionally had the freedom of action within the framework of the chosen projects while they were within the trends promoted by the government. Thus, the main stakeholder of innovations and technologies development and implementation has always been the government. It is important to understand that citizens and even consumers of technology have never been considered as stakeholders. Understanding of the government as if not the only, but the prime stakeholder, still exists in the minds of many scientists. Therefore, the understanding of the national Russian TA mechanism is inextricably linked with the need to produce results for the government.

Today the interaction of the government with scientists signifies the establishment of priority directions of science and innovations development and it also includes the funding of research projects. Grants and government orders set the conditions and limits in which scientists conduct research. The government, in the form of funds, establishes the working order. Even though there is no conventional TA in the research funding, mechanisms resembling TA are required for obtaining research grants. These include the following requirements:

- Technology safety analysis;
- Environmental safety technology analysis;
- Open information-publication of research results;
- And cost and benefit analysis.

As a rule, researchers specialising in the priority fields are invited to answer the TA questions by themselves, since normally, research groups do not include TA specialists. Even if they wanted to attract TA specialists from outside their research establishment, they would probably be faced with failure since it is very difficult to find TA specialists in Russia. As such, these requirements often remain a formality in the grant process. But for those research groups that want to perform TA on the proper level, the answer to their plea for TA specialists is to be found in the initiatives of Russian Universities that promote TA ideas. These initiatives form the beginning of constructive TA in the country.

4.2 Roles of Technology Assessment

In order to analyse the contemporary roles that TA plays in Russia, we applied the “TA impact roles" matrix (see the first chapter of this book). By researching the impact dimensions and issue dimensions we concluded that two types of impact roles of TA are valid for Russia today: scientific assessment and policy analysis. TA in Russia is represented by technical/scientific aspects and policy aspects. It leads to rising knowledge in these areas. Important to notice is that currently there are no societal aspects of TA activities in Russia.

The analysis of various technical projects is being focused on technological or scientific aspects. When the technology or innovation has been assessed the attention of experts is focused on its components, technical risks, and risks of functioning. The first stage of the assessment concentrates on the option of applicability of the technology or innovation, the promptness of obtaining an applied result, and environmental safety. The second stage, in most cases, includes the economic evaluation of the project. So, if the project is valid in terms of the technical implementation and its execution requires reasonable costs, the project will be evaluated positively. For instance, there are three parts in the structure of graduation projects performed by the students of technical majors in Russia:

1) *Description of the proposed technology*
   This part describes the technology, the relevance of its creation or implementation, technical characteristics (dimensions, material, volume, power, potential utility, consumption, etc.), operation mode, etc.
2) *Analysis of environmental and technological safety of the technology*
   This part of the technical project implies a description of the ecological risks and their significance. If necessary, the ecological threats are the subjects for consideration and improvement.
3) *Economic analysis of the technology*
   Cost calculation of the development and implementation of the technology in current economic conditions.

Thus, the assessment of a technical project in Russia currently does not include possible stakeholders, the social consequences of the technology application, or the social impact of the technology in the future.

Another example could be offered. The largest research fund in Russia (the Russian Science Foundation[21]) when selecting projects for funding, assesses the proposed project results by the following criteria:

- High standards of the research (world-class research level);
- Practical application of the results for economy and social sphere;
- And publication of the research results.

This also shows that the social aspects of the research are nearly ignored. The only way of assessing the social aspect of the technology is looking at its usability without undertaking a stakeholder analysis.

Policy aspects

As we already mentioned, the development of policies and legal acts that take TA aspects into account and aim at analysing the political aspects of projects, is one of the priorities in Russia. Such legislative acts in the field of science and technology adopted during the last five years, include the Federal Law "On Scientific, Technical and Innovative Activities in the Russian Federation" that assumes:

1) Analysis of the existing legislative base;
2) Identification of shortcomings in existing laws;
3) Description of directions for the legislation developed in the sphere of scientific, technical and innovative activities;
4) And establishment of an administration of scientific, technical and innovative activities.

Important to note is that the draft of the law implies an assessment of technological projects based on the principles of responsibility, scenario building, and the ability to respond to global challenges.

[21] http://rscf.ru/en

Another example of the legislative acts that reveal TA functions as policy analysis is the "Listing of the Critical Technologies of the Russian Federation" (2011)[22]. This policy was developed based on the following steps:

1) The lists of scientific and technological priorities of all industrialized countries (USA, Japan, Germany, etc.) were analysed and the core priority directions (common for all these countries) were identified.
2) The core priority then was enriched with national specific priorities, like transport, fuel and energy, ecology and environmental issues. Eventually, a list of seventy positions in seven directions was compiled.
3) A Delphi survey was conducted. Experts belonging to academic, university, science, as well as industry participated in it. Experts speculated on how technologies would influence the quality of life, the competitiveness of domestic goods and services also if technologies were economically efficient and could serve as the basis for the development of other technologies.
4) Editing the list was a process of constant consultations with members of science and research councils on the State technical programs.
5) Nineteen ministries and departments, the members of the Working Group, had to coordinate and verify the list.

Societal aspects

Overall, the social aspects of TA are very poorly represented in Russia as no public debates are initiated and no social impact assessment is being conducted. One of the reasons for this situation is the large territory of the country, which has resulted in great regional differences in S&T concentration. For example, according to the index of scientific and technological development of the regions of the Russian Federation calculated in 2016[23], the level of technological development of the regions has significant variability. The first-place region has an index that is more than 13 times higher than the index (level of development) of the region in the last place. (Moscow is in first place with an

22 http://tula.ranepa.ru/nauka/perechen-kriticheskikh-tekhnologiy-rf.php (in Russian)
23 http://riarating.ru/infografika/20171017/630075019.html (in Russian)

index of 82.11[24]; The Republic of Ingushetia occupies the last place with an index of 5.94. The list includes all 85 subjects of the Russian Federation). At the same time, the regions included in the top ten rating produce 64% of all innovative goods in Russia. According to this index, it appears that the remaining 75 regions of the Russian Federation are not oriented toward science, technology, and innovation.

We see these facts as the reasons why starting technology debates in Russia is difficult. Regions are fundamentally different on the level of S&T development, have different awareness of technical projects and different degrees technical decision making. This situation leads to the fact that the existing public discussions are reduced to the debate on local issues and local technologies. For example, the Siberian region unites several nearby territories specialised in various industrial sectors (ferrous metallurgy – Kemerovo Region and the Altai Republic; petrochemicals and oil refining – Tomsk and Novosibirsk region; Chemical Industry – Krasnoyarsk region; Nuclear power – Tomsk region, etc.). The industrial complexes existing in these territories have significant (and not always positive) influence on social, economic, and environmental aspects of people's lives. And, even though the consequences of the impacts touch the entire population of these regions, the local population does not participate in the discussions, because they do not perceive the possibility of influencing the industrial policy.

As an example, on April 19, 1993, at the Russian government meeting it was decided to build a nuclear power station AST-500 in the city of Seversk, in the Tomsk region. The project of this station had never undergone industrial tests. The basis for the construction division of the station in the Tomsk region was that Siberian Chemical Combine (SCC) has been operating in the region from the 1950s. Capable personnel and infrastructure of the existing plant

[24] The index is calculated based on the integral index, which was calculated by aggregating the rating points of the regions based on 19 analysed indicators, combined in 4 groups: "Human Resources", "Material and technical base", " Efficiency of scientific and technological activity», and "scale of scientific and technological activity". The resulting index can vary between 1 and 100.

were supposed to be used for the construction of the new station. Administration of the city and management of SCC actively supported the project. The people living in the city and in Tomsk region were not involved in the decision-making on the project and moreover, they were not even informed. After the project of the station was presented by engineers in 2000, some environmental organisations began to express doubts and dissatisfaction with the project and the idea of building a nuclear power station. However, the public movement in the city and in the region, was not intense. Throughout the year 2000, attempts were made to involve citizens in the discussion process. Public hearings were held, the public examination of the project was launched. However, the main participants of the debate were representatives of the environmental organisations, the city and power plant authorities. The citizens only implicitly expressed their opinion on the project. But according to a public opinion survey conducted in August 2000, about 80% of Tomsk residents support the prevention of the new nuclear plant construction. The discussion is ongoing, but also with lack of participation and influence from the public. A short chronology of the events is:

- 2006 – Creation of a “Working group on the proposals collection on the construction of a nuclear power plant in the Tomsk region”. The group includes 17 people, 16 of them represented different public institutions and one person expressed public interest;
- April 16, 2007 – A protest meeting against the construction of the station in Seversk was held. It gathered less than 50 people, while in the immediate neighbourhood (30-kilometer zone from the planned station) there are more than 700 thousand residents, i.e. more than 70% of the population of Tomsk region;
- 2009 – The expected launch of the construction of the station[25].

The test launch of the station was expected to be in 2017-2018. But currently, there is no information on the state of the project. The above example shows

[25] https://www.seversknet.ru/city/npp/ (in Russian)

that the public is very poorly involved in the discussion on critical technologies. Only part of the population living on the territory of the technology impact is involved in the discussions. And this is despite the fact that the impact of this technology exceeds specific territory and has a nationwide and even global significance.

4.3 Future Desirable Roles for TA

Societal mapping is an obvious TA role for Russia that must be introduced to fulfil the gap that lies between current S&T administration and the potential wide public involvement. As indicated earlier, there are new types of interaction between key S&T players in Russia. Technological platforms (see Figure 1) are a new form of communication between state enterprises, academic science, universities and the commercial sector, to form cooperation in the S&T area aimed at joint development and commercialisation of research results. Though the format of interaction does not imply participation of the wider public, this is a new beginning that might give an opportunity for such collaboration to develop. Beyond this, we can offer an example of a TA initiator in Russia that includes public involvement.

Example of Current TA practice: Robotics

The project "Comfortable Living Environment: Responsible Innovations for Golden Old Age"[26] is a solution for a complex problem, offered not only by the engineers and technical specialties, but also by social scientists, experts in TA. The project is implemented within the framework of an interdisciplinary research consortium (engineers, medical workers, biologists, sociologists, philosophers, economists). It is aimed at the development of market-focused research, new products, and services in the field of Assisted Living Technol-

[26] https://sibdisnet.ru/activity/to-experts/nashi-izdaniya/sovremennye-tekhnologii-zdorovesberezheniya-v-rabote-s-lyudmi-starshego-pokoleniya/ (in Russian)

ogy. In this context, we are talking about innovative engineering developments aimed at the solution of social problems associated with the Perm population aging in terms of self-sufficiency and sustainability. This will not only make the lives of elderly, feeble people easier, it will also reduce the cost loading on the regional government.

In July 2017, the Russian government submitted the program "Digital Economy in the Russian Federation"[27] for consideration to the president. According to this document, within seven years in Russia, there will be about 10 enterprises in the field of advanced IT technologies. 8 hot topics are marked in it. Now Perm Polytechnic University is working on three of them, namely, "Digital Health", "Smart City", "Information Security". In these directions, the scientific and technical background in the field of Assisted Living Technology (for example room climate control technologies, robots' application in the healthcare delivery, the security system in smart houses for seniors) has already been created. The topic of robots' application in the healthcare delivery is especially relevant because many elderly people require help (medication-taking, communication need, etc.). This problem is particularly urgent for assisted living centres and medical institutions due to staff shortages. In this case, modern technology is seen as a rescue. Robots have the potential to solve the following tasks: control over medication-taking; monitor patient's condition (assessment of his speech, motion activity, etc.); solve problems of an existential-psychological nature (robots could entertain people with "conversation" on any given topic, including reading books). Among the social and ethical tasks within the project, the following are highlighted:

1. Development of interdisciplinary research models with a focus on social expertise;
2. Development of a new custody culture (attendance and care) for old, feeble people based on innovative technologies;

[27] http://static.government.ru/media/files/9gFM4FHj4PsB79I5v7yLVuPgu4bvR7M0.pdf (in Russian)

3. Development of an open civil communication platform ("Foresight future: on the way toward Golden Old Ages")[28] with society involvement for the dialogue on the issues in the field of Assisted Living Technology in Perm region.

Thus, we see that the development and implementation of a specific technological case in the field of robotics have led to an active discussion of social, philosophical, and moral problems. The public has also become a participant in the development of advanced robotics in Perm region.

5 Russian Perspectives for Global TA

Generally, TA is understood as an integrated approach in the context of sustainable development ("Shaping technology", "Shaping of innovation"). It implies, in the broader sense, the provision of perspective knowledge or knowledge of the future on the consequences of creation and application of technologies. From this perspective, it can be considered in two ways: as a methodology (practical tool) of assessment of science and technology influence on society, and as a mechanism of government planning and technology management.

The second approach reveals the limited need for TA in Russia. Indeed, in the discourse of Russian policymakers, we haven't found references to TA per se, but the importance and effectiveness of this type of activity is now recognised at the highest state level. Thus, in November 2017, resulting in the APEC Economic Leaders' Summit in Vietnam, the President of the Russian Federation stated that "it is necessary to understand the social consequences of applying

[28] https://mhealthrussian.wordpress.com/tag/digital-health/ (in Russian)

new technologies”[29]. This statement was made in the context of assessing the impact of digitalisation on the transformation of the labour market.

The top board of the Russian Federation Parliament, represented by the Analytical Department, has been involved in the work of EPTA since 2013. The first Deputy chairman of the Committee of the Federation Council for International Affairs V.M. Jabarov stated that the Federation Council sees the great importance of TA, not only within the scope of activity of the Chamber's profile committees, but also with the large-scale involvement of the external intellectual resources. The Analytical Department prepares detailed reports for the Federation Council on various aspects of the influence of technologies on the society. Among the analysed issues are the priorities of science and education development in Russia, problems of ecology, innovation and climate change, the future of transport mobility, employment in the digital economy, technogenic risks, waste disposal, etc. At the same time, the Department is engaged in extensive educational activities, familiarising parliamentarians and all interested parties with the European TA practice and the experience of EPTA. Regular reviews of these issues are published in the Analytical Bulletin of the Federation Council[30].

At both the federal and regional levels, legislative and executive power is based on the consideration of prospect laws for advisory bodies bringing together experts from the Academy of Sciences, the higher education system of the Russian Federation, industry, and business, as well as social organisations. The Scientific and Expert Council, the Integration Club and the Council for Interaction with Civil Society Institutions are working on a regular basis under the Chairman of the Federation Council. By examining key issues, including those relating to science and technology policy, they are implementing a consultative function.

[29] http://www.kremlin.ru/events/president/news/copy/56049 (in Russian)
[30] http://council.gov.ru/activity/analytics/publications/ (in Russian)

Thus, even though the historical roots of Russian parliamentary imply a different process of public decision-making, which is also unlike that in Europe, today we can observe a gradual shift in the paradigm. Participatory ideas and inclusion of a wide spectrum of stakeholders in decision making are key initiatives in Russia today. One of the examples of collaboration is the procedure of discussion of the most important legal act that regulates the future of Russian science – “The Strategy of Scientific and Technological Development of the Russian Federation”. The development of this document started June 2015. Consolidated vision development required 10 expert groups. They were formed on key research areas: “Science and Society”, “Science and Economics”, “Science and Business”, etc. They included experts from various fields, especially representatives of the science and educational complex (universities and Russian Academy of Science), to develop the proposal. The provisional results of the project were discussed within the framework of the Scientific Coordinating Council of Federal Agency of science organisations, the Council on Science of the Ministry of Russian Federation, at the forum “Technoprom” in Novosibirsk, and on economic forums in Krasnoyarsk and St. Petersburg. Moreover, the draft strategy was put to general discussion. All interested parties could leave their comments on the draft law and recommendations on its elaboration on a special internet-portal. As the deputy Minister for Science Trubnikov stated, it is easier to implement the processes of development and reform of the industry if society understands why it is done. As a result, the final version was approved in December 2016 by the President of the Russian Federation. It is necessary to note, that this document for the first time relates the strategic level of science and technological priorities with global challenges (“big challenges”), including negative social consequences of technologies.

Another example is the National Technology Initiative (NTI). NTI is “the program for creation of fundamentally new markets and the creation of conditions for global technological leadership of Russia by 2035”[31]. As in the above-

[31] https://asi.ru/eng/nti/

mentioned strategy, the essence of NTI is formulated not only by the government but also by a limited stakeholders' community. Working groups have been formed to discuss prospective markets, including representatives of governance structures and, above all, private capital. It is a problem of fundamental science to estimate and predict prospective trends, so the structure of expert groups required representatives of research and educational areas. The main result of their work implies clear road maps for relevant sectors of the economy: the development of key directions like AeroNet, AvtoNet, HealthNet, Foodnet, etc. for the next 15 years. The developer of NTI (D. Peskov) states that the task of NTI is not only to overcome technological barriers, but also to consider social barriers that prevent the emergence of breakthrough initiatives in Russia. The problem of selecting scientific groups that are capable to solve such problems (social, ethical, political, cultural, etc. context) is not resolved at present moment.

The essentials of the Russian mentality lie in the fact that the investigation initiative of various kinds of technological influence does not come from the public (as it happened, for example in the USA) and does not even come from the government (as it happens in several European countries for example, Germany). The main initiator of research of this kind is the scientific organisation of Russian Academy of Science and science and educational structures, overall universities.

Therefore, the government not only attracts representatives of science and education as experts in various advisory boards, but also uses universities as discussion platforms to identify problem areas. Moscow State University hosted a joint meeting of the Integration Club under the Chairman of the Council of Federation on the subject scientific and technical cooperation. The final document noted the high need to establish a permanent national structure – a special body on technology assessment[32]. In addition, Russia recently adapted an initiative to implement the concept of RRI and to practice TA in

[32] http://council.gov.ru/media/files/rAMxTGk0OVCzWQHTXaq4AwGba6Iplopl.pdf

educational programs training specialists. A number of leading universities, especially of the technical and engineer majors, identified responsibility as one of the key competences of future professionals, understanding both the broad meaning of this concept and the narrower its connotation – responsibility for results of the scientific and innovative activity.

The National Research Tomsk Polytechnic University (TPU) was one of the first to proclaim the commitment to the concept of sustainable development and chose the problems of resource efficiency. Experience of the interaction of TPU and the Institute for Technology Assessment and Systems Analysis (ITAS) in Germany allowed the university staff to add a course on “assessment of consequences of technical decisions” in the structure of the education program of Bachelor students whose major is Nuclear Power. By completing the program, students of TPU will be able to carry out the critical analysis of problematic situations and develop a strategy of action when making technical decisions, focusing on the principles of RRI and TA using methods and tools.

Summing up, it should be noted that certainly as in any other country, TA in Russia has its unique features. First, it is connected with the historically formed mentality of the citizens of our country. Since the time of the Empire, the (governing) power in the minds of the Russian people had sacral, almost divine meaning. Its criticism, in any form, was perceived as a violation. During the Soviet era, the Communist Party's leadership role was also never questioned. All the full rights of the decision-making processes and all responsibility for their fulfilment were placed on the government people in any area of life of society.

Today we witness a shift of emphases. The role of various communities and representative offices in the social and political life of our country has greatly increased. Participation is seen as a necessary factor in the decision-making of municipal and regional government. The federal legislation increasingly relies on the authority of the expert community. Accordingly, the category of responsibility is now considered in a broader context. The opposite movement is necessary for the formation of a participatory culture among the population. This applies both to public debates and to the overall appearance of civic initiative. The public should be the initiator of TA projects, acting as a customer and simultaneously as a consumer of results. Lobbying of individual interests should give way to the ability to consider the opinion of all interested parties and the culture of mutually advantageous compromise.

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Constructing a Global Technology Assessment – Its Constitution and Challenges

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What should a global TA look like after all? Throughout this book we can read insightful descriptions of the state-of-art in a number of countries across the globe. At a first glance the differences are great and the challenges enormous, but we can also identify commonalities. The differences derive mainly from the decision making structures and the culture of public debates in each country. If for instance, a policy system is not used to multiple inputs, vivid argumentation and conflicting stakeholder perspectives, it will evidently be hesitant to accept a TA that is based on such processes. On the other hand, the commonalities are much more prominent and urgent. They are nothing more than the focu of TA: the consequences of scientific and technological developments on society, the environment and the economy. These are almost identical in all countries and they require urgent common attention. One could argue that the evident political and social differences in the countries represented in this book, pale in front of the need to construct a common methiodology of assessing S&T developments.

The analysis of the individual countries in this book allows us to draw conclusions about a framework on which a possible global TA could be based and the flexibilities that are a prerequisite in creating a common process amongst the many different cultures and societies.The aim is not to iron out differences but rather to specify a normative aspect that the framework can be based upon.

Whether we need a global TA approach is not questioned here. As the first chapter on "The Case for a Global Technology Assessment" shows, there is an increasing requirement for TA to adapt to the simultantuous and worldwide reach of S&T and that some challenges can only be met on a global level. That is our starting point for this book. In this sense, a global TA is needed and will be developed in any case. Our purpose here is to account for the conceptual process of its creation, based on the informed opinions of national experts. This is as close as one can get to a global debate amongst TA experts at present. As such, this book does not present a final answer to questions revolving around global TA. These will have to be re-visited with any newcomer in the debate. They will have to be continuously developed and result in new approaches. This is the nature of TA as an disciplinary concept. What we offer here is a point of departure for this process that will eventually create a global TA.

1 The Creation of a TA Habitat

The first issue of conceptual importance in the development of global TA is what kind of environment one needs to have in order to promote a global approach. By that, we mean what is the single most important denominator for the development of TA in a nation-state that can be extrapolcated at global level. The immediate reply would simply be: the existence of an advanced S&T system. Advanced in the sense of S&T being a policy priority that is translated into a clear governance system. This is naturally a prerequisite but it is not enough.

As we have seen for instance in the case of European TA (see chapter on "European Concepts and Practices of Technology Assessement"), more important than a governance system is the creation of a "TA Habitat" (Hennen & Nierling 2015). This idea of a habitat for TA is useful as it can help determine the elements needed and possibly missing for establishing a functioning TA in a national context. How decisions are made and on which (public) knowledge these are based or how decision makers are held accountable for these decisions, are questions relevant for identifiying a TA habitat. Other aspects identified as being supportive to the development of TA structures are, the existence of problem-oriented or hybrid research activities (such as STS, environmental research or risk and security research) in the academic sector, a significant public awareness of and interest in S&T issues and, an articulated demand for or need of rational and non-biased advice in matters of S&T development and its societal implications in policy making.

Most of these elements were present when in the 1970ies and 1980ies TA concepts were developing and TA institutions were set up in the US and Western Europe. Political and socio-economic situations differ, to a great extend, nowdays significantly from those times and countries in other regions of the world face different challenges. We nevertheless hold that the identified aspects of a TA habitat to some extend, although with some cultural variation, are necessary to establish an expressed need for as well as provide elements (practical, methodological and institutional) that make TA happen.The absence of these elements can tell us something about the structures, institutions or processes needed for TA to flourish on a national level and what roles and functions it should take on. The question in the context of a global TA level is then, if we can use some of these aspects of a fruitful TA environment for identifiying needs beyond national boarders. In this respect, we observe features and framework conditions that point into the direction of a global TA habitat. There is of course international (global) exchange of academic communities (sustainability research, STS, risk assessment, science ethics) which can be supportive for and interested in setting up global TA activities. There also appears to be something like a transnational public interest in issues such as climate change, biodiversity and others, indicated for instance by globally active NGOs and by web-based international exchange of civil society organisations on S&T matters. And there are also clients on the side of policy making, i.e. all those involved in international negotiations on conventions and treaties or international consultative bodies at the UN, who are in need of independent support in assessing the options as well as possible problems given by R&D with respect to societal challenges on a global level.

Overall, the creation of a TA Habitat assumes a common agreement on the parameters that are needed in order to develop global TA infrastructures. Every national perspective (including the EU one) in this book has described the key national aspects that need to be taken into consideration for a global development. These aspects form the parameters of global TA and are described in the following.

2 Global TA Parameters

When it comes to the development of a global TA, we can identify a number of parameters that will help us delineate it. But it is important to understand that in a global system, parameters are not fixed as binaries of "xy prerequisite" is there or it is not. Parameters refer to a continuum, whereby the focus is to identify how much of "xy prerequisite" is there. This is a pivotal aspect in our inquiry, since it is important to have adequate flexibility in identifying the necessary preconditions for the development of a global TA. For instance, if one sees Democracy as a binary variable (i.e. a system is either democratic or not), one will inevitably exclude the majority of world nations that do not conform to his/her specific definition of Democracy (usually, the standard pluralistic, liberal, non-religious western type). One the other hand, if one sees Democracy as a continuum (i.e. political systems have "more" and "less" democratic practices), one should then strive to identify the limits in this continuum, outside of which TA is not possible. This still leaves enough flexibility to accommodate a number of top-down and bottom-up systems in the same parameter where TA collaboarions are possible and desirable.

With this in mind, we have identified the following parameters that are necessary in the creation of a global TA. Each of them represents a methodological concept that should be explored when applying a common TA.

2.1 Political System

The first and outmost parameter to take into consideration is the political system of the countries that are part of the global TA effort. They range significantly, even in the small sample of our book, from multi-party to one-party systems, from liberal to authoritarian, from socialist to capitalist, from social welfare oriented to free market oriented, etc. We have seen that, independent of the political system, there is a need for the assessment of the societal embedding of advanced technologies, by e.g. effective risk management or addressing of ethical issues. There is no political system, except perhaps that of pure dictatorship, that can completely disregard legitimising policy measures through rational articulation of problems and taking into account the expectations of affected and concerned publics. Thus, there is an ubiquitous, although sometimes unexpressed, demand for TA. Nevertheless, when thinking about TA's societal and political role one needs to take the differences of political decision making structures and political cultures into account. That will require a political economy analysis that is usually not standard in TA, but nevertheless becomes necessary in this context.

A relevant question on political economy in terms of TA development is: can TA be at all possible in a non-liberal political system? This is of course pivotal, since a negative reply would severely restrict the scope of global TA. The debate on this issue is new and has already produced clear arguments on the negative, i.e. TA is not possible in an illiberal system (Grunwald 2018), and also on the positive, i.e. TA or similar activities are possible in an illiberal system (Wong 2016). Our view is that, both arguments are right and wrong at the same time, since they lack the definition of liberal/illiberal system. For instance, a dictatorship is an extreme example of an illiberal system whereby TA is indeed not feasible as the system would not even allow for basic independent thinking, let alone for meaningful public inclusion. But, is a one-party system prohibitive for TA? We think not. Freedom of expression does not depend on the number of parties running for government but rather on whether the decision making system allows freedom of expression altogether. For instance, we have examples of public protests in China (i.e. one party system) that, not only have not been repressed, but have also led to concrete policy changes (see chapter on "Technology Assessment in China"). And on the other side, there are serious worries that some European (i.e. multi-party system) governments suppress freedom of expression through media (Hennen & Nierling 2018). Moreover, with the recent success of right wing populist movements in Europe and their apparent disregard of science expertise, there are reasons to fear negative effects on the conditions for TA to fullfill its role and mission, e.g. holding on to TA's role as a "neutral knowledge broker" in policy making (e.g. Hennen & Nierling 2018).

This leads to questions of the normative foundation of TA, which as some argue, has historically been a Western democratisation project, and as such inherently democratic in its methods (Grunwald 2018). Yet, as others argue, it can be worthwhile to look for moral foundations of universal claims (such as the participation of public in S&T decisions) in different contexts. If these different ethical-political traditions (e.g. Confucian thinking) have different values and these are at least on a par with liberal democratic ones, then these traditions should be taken more seriouslyinto account in research on global governance and ethics of specific global S&T developments (Wong 2013). There is still a vivid discussion in Europe whether and to what extend TA is bound to democratic values, i.e. to what extend TA is bound to certain political values or norms (Hennen & Nierling, 2018). It is quite clear from the history of TA, in conceptual discussions and in current TA practices that TA is bound to open, transparent and rational discourse of S&T related problems. The inclusion of all relevant actors' perspectives in the assessment of S&T, beyond the closed circles of S&T experts, is part of it. The issue here is to what extend the political context that TA is applied in, provides room for modes of S&T appraisal that the TA is methodologically and conceptual committed to.

Overall, in order to move forward towards a global TA, it seems unsatisfactory to point to the differences (and there are plenty) in the normative foundations of TA or the political systems surrounding it. The value of the parameter of the political system is enhanced by identifying its limits. Neither a one-man rule nor an anarchic system would be plausible for the development of TA. But many in-between systems would form an acceptable continuum where TA could take place fruitfully in collaborative activities. The necessary conditions would be: freedom of expression and willingness to accept open debates. Freedom of expression is obvious but the latter requires further qualification. A debate is necessary in TA whether it should take place in closed doors amongst a group of experts, or it is acted in the media with a plethora of interest groups and individuals. As we have seen before (see chapter on “The Case for Technology Assessment”), both are valid ways to do TA and both include a number of established methodologies along the continuum of classical-participatory TA. Both incorporate arguments and perspectives that are contradictory and challenging. A system that does not accept contradiction and is weary of challenges, is incompatible with TA.

Furhtermore, one has to be clear that public participation is not the only prerequisite for an ‘open system’. Whether participatory TA is the preferred variety of TA chosen or not, it is not a sign of ‘openness’ or ‘closeness’ in the system. One has only to review the literature on the impact of participatory TA in policy making to find out that participation is by no means the most successful policy input (Hennen, 2002). As such, there is reason to believe that even in apparently liberal systems, decision making can be closed and elitist. Therefore, openness should be defined as the willingness to accept different perspectives, not simply to accept or not the most public forms of TA.

Concluding, the policy system is an analytical unit in global TA and must be taken into account in every attempt towards global collaboration with the help of political science and political economy. The prerequisites of freedom of expression and openness of the system, for a successful TA application, must form the constant variables underpinning the creation of an acceptable continuum.

2.2 Science and Technology Governance System

Next to the political system, the governance system of S&T is also a relevant parameter. This refers to the administrative set up around the S&T decision making process, in other words, who decides what, where and at what point. This is an important variable in global TA as there are significant differences among countries in decision making structures that need to be taken into consideration. For instance in Germany, the federal governance system allows for the creation of state-level Ministries of S&T that are active in technology development and require regional TA capacities. As a result, some German TA institutes also have an exclusively regional focus in relation to their national one. India is also organised in a similar manner although there are no regional Ministries. In other countries, such as Australia and China, S&T decision making is mostly centralised under a single decision making structure.

Europe is a unique case in this parameter, as it also represents another level of S&T governance: that of a multi-national (or, trans-national) governance. As we have seen previously (see chapter on “European Concepts and Practices of Technology Assessement”), the European Union is a strong governance entity with significant resources and decision making capacities in S&T. This poses a number of challenges, but foremost, many opportunities of organising governance structures that have not been possible before. As a result, it requires a particular brand of TA that is evident in the multi-national organisation of the European Parliamentary Technology Assessment (EPTA). This is an example of how different countries with different decision making systems can create a common TA. As discussed previously, EPTA can be seen as a microcosm of a global TA, although significant differences between a European multi-national TA and a global level still remain.

For the development of global TA, the next governance level is more appropriate: that of global governance. This should not be seen as a reference to a 'global government'. A global government is not necessary and certainly not desired by most nation states in the world. Rather, governance here refers to global decision making structures in S&T. This is less controversial since there is an acknowledged need to develop such a system and there is also a precedent. The need comes from global issues, paramount amongst them is climate change, that requires common structures in decision making. The United Nations Convention on Climate Change is such an example, whereby countries have agreed upon a common approach and a regulatory mechanism, albeit voluntary. Another key precedent in global governance is the World Trade Organisation that includes strict governance rules of trade with arbitration and penalty mechanisms that do not differ from any standard national governance system.

For TA, the UN system provides an opportunity for global TA through the Technology Facilitation Mechanism (TFM). This is a new international body at the UN where governments, civil society, business, the scientific community, UN agencies and other actors can collaborate, network, discuss and evaluate how different technologies can help or hinder the achievement of the Sustainable Development Goals (SDGs)[1]. TFM is the result of the Rio+20 summit of world leaders in 2012 discussion for the need to explore a global mechanism for technology facilitation. Although there are already several UN bodies whose work impacts the development, transfer and dissemination of clean and environmentally sound technologies, they do not coordinate with each other, and the definition of what is meant by "clean" and "sound" technologies is ambiguous. One aim of the TFM is to ensure coherence, coordination and cooperation among the different initiatives, programs and institutions working on science, technology and innovation across the UN. For this aim,

[1] For details see UN InterAgency Task Team on STI for the SDGs at: Sustainable development knowledge platform (United Nations): https://sustainabledevelopment.un.org/tfm

the TFM attempts to clarify methodologies for assessing relevant technological developments in terms of their usefulness for the SDGs, that draws directly from TA.

Overall, the parameter of S&T governance is a continuum that spans from regional, to national, to multi-national, to ultimately global governance systems. A global TA can and must function in all of them, by creating regional, national or global collaborations for the assessment of regional, national or global S&T developments. Although the concept “global” directs one’s thoughts to global problems, this is not the only focus. There are regional similarities in very dissimilar countries that have much more to share in terms of challenges and assessment needs than the countries themselves. One could think for instance, the regional energy powerhouses in Tomsk, North-Rein Westphalia or Tianjin as needing a common TA programme of the effects of energy transition, that are specific to their significant similarities. On the other hand, the issue of climate change is not regional or national. It requires global approaches and a single decision making mechanism, hence, ultimately a single TA process for the whole globe. In between these two extremes, there are myriad possibilities for TA collaborations at national and multi-national level.

2.3 Socio-Economic Development Stage

As we have seen in the contributions from some non-European colleagues, national S&T priorities are closely connected to development needs. This is to be expected since different countries have different development trajectories that require a different focus in S&T developments. Basic needs such as water, food, housing, etc. are a priority for any society that lacks them and an effort to assess the S&T development that deal with them should also be on top of the TA list. This does not preclude the parallel development of a high-tech sector that requires a significantly different approach in terms of assessment. As a matter of fact, there is hardly a developing country in the world today that does not need to deal with both low and high technology developments at the same time. At the same time, a developed country could benefit from redirecting its focus to low-tech S&T solutions, especially regarding sustainability aspects, such as energy needs. As such, there is an opportunity for significant developments in TA methodology at global level.

One such opportunity is to be found in frugal innovation. This refers to low-tech innovation to be found in less developed regions of many countries that requests a different approach to assessment than the high-tech innovation that TA is usually focusing on. Frugal innovation is a paradigm that would require different TA methodologies than the current ones, perhaps with greater focus on societal needs, government spending and intellectual property rights. This has been discussed in the context of TA for sustainability and development, which requires new models of TA (e.g. networked, flexible) (Ely et al. 2011). Furthermore, colleagues from developing countries that have worked in the area can provide vital input in the development of TA that captures such innovation potential.

2.4 National Values

Values play the role of organiser of thoughts but also as norms of behavioural guidance. They provide concepts upon which action takes place in society and as such are a key ingredient in every debate whether on S&T issues or otherwise. Naturally, values are influenced by history and culture, both of which have unique national or even local characteristics. Efforts to analyse the incorporation of values in the S&T decision making, have been taken into consideration in the making of this book (Ladikas et al. 2015). Every national perspective has therefore provided an opinion on the main national values that have to be taken into consideration when developing TA. The importance of values in decision making cannot be overestimated and their role in developing a global TA is far from resolved. The reason being simply the apparent incompatibility amongst different national values systems.

The solution to the conundrum of values differences is to be found with the help of yet another continuum. The analysis of the values systems in Europe, India and China has shown that the apparent differences in the expression of values that govern S&T policy making, can be bridged if described on continuum scales (Ma et al. 2015; Chaturvedi et al. 2015; Stemerding et al. 2015; Brom et al. 2015). For instance, the following figure describes the main values of Europe, India and China in terms of the basic conceptual similarities or kinships and affinities:

Individual (rights)	⟺	Group (harmony)
Justice (equality)	⟺	Access (equity)
Dignity (autonomy)	⟺	Progress (peace)
Solidarity (inclusion)	⟺	Peace/ Access (inclusion)
Sustainability	⟺	Sustainability (affluence)

Figure 1: Relations between main values

The apparent dissimilarities in the description of national values that are recalled in S&T policy documents in the three regions, are seen in a different light when perceived as being complementary. For instance, the problems of balancing individual and collective interests and rights as well as related values are expressed and addressed by the constitutional protection of individual human rights in Europe. The same dimension and problem of societal integration is addressed in China with the concepts of societal harmony and group rights. This means that both concepts fall under the same category, which also has a lot of intermediate values: individual rights in Europe are sometimes less prominent, e.g. in case of national threat situation; and on the other hand, individual rights in China become more prominent in cases of abuse of power. Overall, the timing and context is more important for the expression of this value than the original intention.

The same holds true for the other values of the graph. For instance, justice in Europe is related to equality, while in India it is seen as access that relates to equity; as access to S&T developments is more or less assumed in Europe, equality before the law is more prominent, while in India access is not guaranteed and therefore justice is a matter of equity between the people of the country. One can continue in a similar manner with the analysis of the other values, but the main point remains that there are far more similarities between national values in the world than one might perceive at first glance. The common understanding of national values affecting S&T policy is a crucial point of the development a global TA.

3 Global TA as Science Diplomacy

Science diplomacy refers to the process of creation of scientific collaborations in order to deal with common policy problems. It is the realm where science and politics overlap and there are plenty of examples in which science and politics are strongly intermingled at internaitonal level. Perhaps the most prominent of all examples is climate change, whereby scientists and diplomats has been working closely together to develop functional solutions based on scientific thinking but accepting the realitis of national politics as well. One can find many more initiatives, ranging from bilateral to regional to global ones and targeting highly poiticised issues (e.g. atomics energy) to purely basic needs targets (e.g. medicines), that diplomacy is a significant part of the scientific collaboration.

Overall, science diplomacy is evident one way or another whenever international collaborations are necessery in achieving scientific results. Regardless of whether there is more emphasis on the politics (e.g. science as foreign policy advisory), or on the science (e.g. policy facilitates common scientific collaborations), science diplomacy is the means to achieve the main aims.

Global TA should be seen as part of this trend with a unique area of functioning. As we have seen in the countries represented in this book, TA as policy advise is close enough to policy making to understand the intentions and agendas of national politicians, and is also close enough to the scientific world to acknowledge the opportunities and limitations of science at national level. This intermediary role between science and politics, results in distinctive opportunities for TA practitioners to function as “science ambassors” representing both science and policy pespectives at international level. Moreover, the core TA function is to explore the implications of scientific developments on society, economy and the environment. This is also the target of any international scientific collaboration that is by default organised around grand societal challenges (e.g. climate change, SDGs, etc.). As such, social impact analysis is a necessary ingredient of any cross border science policy collaboration and TA is a natural expert in it.

For these reasons, a Global TA is a strong developer of science diplomacy and can easily be seen as its natural promoter. Global initiatives such as the TFM discussed above, represent an appropriate stage for science diplomacy based on TA processes. The developmental aims of each nation are a sovereign decision based on internal politics, but the mechanisms of technology transfer depend on international collaborations that are based on both trans-national politics and scientific possibilities. What technology transfer contains and how it can be achieved, is a matter of analysis with an equal dose of political and scientific input. TA can fulfil this role by incorporating diplomats (e.g. science attaches) in its assessment process.

4 Final Thoughts

The analysis of national TA with a view to international that the book has given, provides a step towards the ambitious goal of creating a global level to

TA. There is still a long way to go in order to turn the conceptual insights described above into practical applications in these countries. Through the contextualisation of TA on the various national levels, including its location in the S&T systems as well as its priorities and underlying values, we can add substance to the parameters described above. We can then see that TA in China, for instance, takes place in a complex setting of priorities derived from Confucian values such as virtue and harmony, in a political and economic setting between radical market-driven and top down planning economy.

The same can be said for the other countries described in the book. TA in Australia has to find its way between an economic and political focus on prosperity through innovation and, next to values of equality and freedom, that of sustainability. In Russia we find the legacy of Soviet technocratic approaches to S&T and emerging needs for more effective policies for S&T development, where TA remains unknown, even though the need for it is apparent. Germany represents a country with established forms of TA in a wide variety. Yet, processes of including the public through participation and transformation processes create tensions within the German representative democratic system, which TA has to take into consideration. India's challenges concern very basic needs as well as access and equity or diversity, yet the country also strives towards big science, which still remains a priority. Here TA has to find ways towards resolving these tensions.

This leaves us with a point of departure. Identifying similar values, understanding how TA works along different stages of political or socio-economic realities, helps us find common gorund as a basis for global TA. Overall, TA's aim is to make S&T developments work better for society, based on its needs and expectations. By providing insights and descriptions into the national contexts we can see how this is done in practice as well as what is lacking in the national perspectives. Next to the necessary nation-specifc TA, we get a better understanding of where is the common ground towards a global TA. As such, we have found enough solid ground as well as sufficient challenges to start the development of a global TA. The primary task is the development of a global TA network. For this, we can rely on the existing bi- or multilateral cooperations across borders and continents. International networks discussing the concept of TA and assessing S&T developments should be joined by those of international policy making addressing issues like climate change, sustainable energy, bio-diversity, and SDGs. Global networking and setting up global platforms for conceptual exchange and joint TA-projects is the task ahead in order to make the dispersed practices of cooperation grow towards a global TA community.

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Constructing a Global Technology Assessment

Worldwide simultaneous effects of technologies, international challenges such as climate change as well as shifting relationships between science and society call for approaches that can address these issues on a global level. This book examines the potential of Technology Assessment (TA), as an until now mainly national and Western concept, to take on this global level and provide answers to these pressing questions. With a unique array of countries from across the world, this book gives in-depth insights from experts regarding TA-like activities in China, Russia, India, Australia as well as Europe including perspectives on future needs and developments. In this way, it represents a starting point to begin thinking about and constructing TA as a common global prospective and in a comprehensive way, including potentials as well as limits of a global Technology Assessment.

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