considered as socially relevant (Weingart 2008). Application-oriented technological science, for example, is often directed at economic relevance or applicability, while this *commodification* of science also is strongly contested by other parts of the science community (Radder 2010).

Next to economic usability, science may pursue other societal targets. Sustainability sciences, beyond investigating sustainable development as a *research subject* often also pursue sustainability as a *normative target*. The value of science is not purely seen in science as such, but science is viewed as a means to an end, in need of a normative direction (Ziegler 1998; Smith et al. 2010; Jahn 2013). *Development* is yet another potential societal objective of science and science policy. In order to have developmental impacts, science is often conceptualized as an impact-oriented or problem-solving type of science (Rhodes and Sulston 2009). Similarly, adherers of an engaged programme of science and technology studies seek to enhance a *socially responsible* science (Sismondo 2008) or to raise the *accountability* of science towards society (Jasanoff 2003).

Different interpretations of the links between science and society and diverse conceptualisations of scientific production and their corresponding effects on society thus coexist within the scientific community as well as in science policy (Glerup and Horst 2014). In drawing attention to these different conceptions, I'd like to emphasize the socially constructed nature of science. At the same time, the coexistence and potential plurality of conceptions of the relation between science and society raises the question why certain views persist at certain points of time in specific scientific communities as well as in science policy.

## 2.2 Science policy and society

Scholars point to the essential role that policies play in setting a future course and for framing societal problems, solutions and standpoints. As Clay and Schaffer noted in 1984 already, "policies can make a difference. Different policies could be chosen. There is room for manoeuvre" (1984: 1). Next to the relations between science and society as such, their governance on different levels is therefore receiving increasing attention. Due to the internationalisation of research and world-wide spread of the technologies produced, international policies with their influence on scientific networks and cooperation become important next to policies focussed at the local or national level (Smith 2009; European Commission 2009; The Royal Society 2011). The policies themselves turn into a topic of interest, as they are perceived as a lever setting the conditions for potential impact on society, including development (Bucar 2010; STEPS Centre 2010).

Science policy, in a broad sense, refers to those policies directed at fostering, organizing and steering research activities. Sarewitz et al. for example define it as "the decision process through which individuals and institutions allocate and organize the intellectual and fiscal resources that enable the conduct of scientific research" (2004: 67).

Science policy – sometimes also termed research policy, science and technology (S&T) policy, or science, technology and innovation (ST&I) policy – is a research subject in different social sciences, including specialized disciplines such as science and technology studies and science policy studies. Within these, a range of distinct perspectives can be differentiated, drawing on different social science disciplines. On the one hand, non-normative, often philosophical issues about the nature of science policy are addressed, such as the relation between science policy and other policies, or between science policy and its impacts and further effects on society. In this line, some scholars direct attention towards science policy and governance and its function towards steering the direction of science. Authors such as Nowotny et al. (2001) or Weingart (2010) reflect on the (im)possibilities of steering science, others on changing ST&I governance structures (Jansen 2010).

In another strand of literature, a focus on the systemic effects of policies prevails. From this perspective, policy or governance are analyzed in view of their function within national ST&I systems, possible effects of policy on ST&I, including complementary functions such as in view of strengthening science-industry relations in order to foster economic development, or, in case of engaged strands of Science and Technology Studies, on the interrelations of policies, ST&I and a broader public interest (among others Perry 2007; Sismondo 2008).

In current debates, science *policy* is increasingly reconsidered as *science governance*. Conceptualizing science policy as science governance broadens the concept's scope: Next to the role of bureaucratic or political actors, officially mandated by the state, the role of multiple actors, structures and discourses outside of the bureaucratic national set up is acknowledged, which are considered to influence decisions and directions of ST&I (Irwin 2008; Stirling 2008). As I am focussing on the BMBF as a main actor of science policy, I will stick to the term of *science policy*. Nevertheless, I am aware of the role of other actors – which is reflected in the empirical chapters.

Science policy in its current profile is an invention of the second half of the 20th century. Only then did governments begin their efforts to steer science through science policy, which relied on the mechanism of granting funds for research conditional on the topic (Elzinga and Jamison 1996; Stichweh 2000; Sagasti 2013). US-science advisor Vanevar Bush's report on *Science, the Endless Frontier* (1944), which lead to the establishment of the USA's National Science Foundation in 1950, can be seen as an emblematic document of science policy, influential on later science policy in stressing how science should work for societal objectives (Guston 1997; Sarewitz et al. 2004). After the Second World War, and with the upcoming Cold War, many national science funding institutions were created and investments in science in the USA and Europe as well as in the Soviet Union arose. These were mainly directed at building up capacities in research related to strategic defence technologies such as nuclear technologies, materials research, or aerospace engineering, while solving societal problems through science, such as through medical research, also played a role (Gassler et al. 2006; Neal et al. 2008). Science policy thus is often closely linked to other policies and instrumentalized to fulfil their corresponding objectives (Bozeman and Sarewitz 2005; European Commission 2009). However, next to following political objectives, the directions of science policy have also been influenced by public debates on science, such as in case of genetic engineering (Elzinga and Jamison 1996).

Science has been funded based on different notions of its role for society. After a phase of conceptualizing it as a *motor of progress* in the mid-20$^{th}$ century, science policy later targeted science as a *problem solver* and *source of strategic opportunity* (Ruivo 1994). In a major shift of paradigm, science policy has been reconceptualized as *science and innovation policy*. Since the first uptake of innovation as an objective of science policy in the 1970s, the emphasis on innovation (ch. 2.4) has increased steadily (Weingart 2011). Other authors have detected similar patterns of increasing focus of science policy on economic innovation and competitive technological change in the developing world (among others Röling 2009; Conway et al. 2010; Sagasti 2013).

The short overview of historical and current directions and orientations of science policy illustrates an essential point I want to make: In general, science policy *could* direct science towards any political aim and goal and has indeed tried to promote quite different objectives throughout history. These are predominantly not scientific objectives, but science is promoted as a means of reaching an objective *beyond* science, within other parts of society (Sarewitz et al. 2004; Sarewitz and Pielke Jr. 2007). Despite the philosophical debates about the relation of science and society, with Polanyi and Merton as prominent defenders of autonomy, science policy is mainly conceptualized as a mediator between science and society and is directed at objectives beyond fostering scientific productivity as such (Miller and Neff 2013).

Science policy thus always has a normative direction, which is not predefined: Potentially, science policies could be used to contribute to all possible scientific or technological development pathways. Theoretically all dimensions of human life could be targeted, such as fostering economic development, solving societal or environmental problems or making better political decisions (Nowotny et al. 2001; Sarewitz et al. 2004). Policies, as well as the systems that they are designed to support, are open to multiple goals, as they can be framed in a multitude of ways through different "contextual assumptions, methods, forms of interpretation and values that different groups might bring to a problem, shaping how it is bounded and understood" (Leach et al. 2010: 4). Science policy thus displays the choices and values underlying it (Leach et al. 2012). Which directions of science are pursued, which issues are successfully pushed onto the agenda is a matter of influence and power – and of a predominant discourse (ch. 3).

At present, national science policies all over the world view science mainly in terms of its relevance and applicability to other societal spheres. Science policies purely aimed at strengthening science as such are scarce (European Commission 2009). Science policy often becomes part of a larger set of policies that shall contribute to an economically defined development agenda (Evers et al. 2006; Hornidge 2011). Given the skew towards economic objectives that can be observed in existing science policies all over the world, it is little surprising that scholars have also tried to come up with explanations as well as models of how to reach different objectives. Authors such as Jasanoff (2003), Bozeman and Sarewitz (2005), Sarewitz and Pielke (2007), Stirling (2008), Leach et al. (2010), Arocena and Sutz (2012), Guston et al. (2014), Taebi et al. (2014) or van Oudheusden (2014) view science policy from a critical perspective and argue that science policy should mediate between science and society's needs and align demands in order to endorse public values – which are not necessarily congruent with economic values. In view of economically defined science policies, Bozeman et al. express their concern that "market interest for S&T sometimes overpowers our ability to think systematically about science as the engine of social change" (2011).

While some authors, such as Guston, Taebi, or van Oudsheusen, explicitly draw on the concept of "responsible research and innovation", which emerged in the early 2000s, other scholars refer to similar notions without using the term. Authors in this line of argumentation take a strong normative perspective and argue in favour of responsible ST&I and the accountability of ST&I and the accompanying policy towards the public. The authors share the idea of ST&I as socially constructed phenomenon, emphasize the role of policy and cocreation of knowledge, thus calling for new participatory governance schemes. Policy responsiveness to societal needs is a key feature of responsible ST&I.

Authors therefore propose a close interaction of diverse stakeholders in inter- and transdisciplinary decision making and agenda setting in the policy process in order to reach deliberative, participatory, responsive policies, and in consequence "a more inclusive, democratic, and equitable science–society relationship than is presently the case" (van Oudheusden 2014: 72). Participation has been theorized from different scientific angles, including development research, social sciences and political sciences, and with different normative stances. Participation describes the phenomenon that actors who are not regularly part of a decision process (in policy making as well as other social practices) take part in decision making on issues of public relevance. Participation implies that power is transferred to the participating actors (Newig 2011).

Authors from development-oriented research, such as Arocena and Sutz (2012), Stirling (2008), or Leach et al. (2010) approach science policy from a perspective of social and environmental justice – but reach a similar conclusion. Arocena and Sutz argue for the inclusion of stakeholders in decision making as well as transdisciplinarity in research, but also emphasize that the current academic incentive and reward system does not encourage the cocreation of knowledge or development-oriented science. They conclude that further research is necessary to study which channels of influence there are to express the needs and problems of the poor and translate them into policymaking (Arocena and Sutz 2012).

Participation in practice may be motivated by different objectives. It may be aimed at increasing emancipation of the public and democratizing society and be conceptualized as a means towards balanced decisions which take into account the needs of different groups. On the other hand, it may be aimed at increasing the legitimacy of decisions and/or efficacy of actions through public acceptance (Newig et al. 2011). This promise has led to its adoption on various political levels. In the European Union, for example, participation has been inscribed in various white papers and directives in order to enhance legitimacy of its policies and to improve their implementation (Newig and Fritsch 2009; Schaal and Ritzi 2009; Newig et al. 2011). Similarly, the BMBF makes use of participatory agenda-setting processes in designing its research programmes (ch. 7).

Stirling, Scoones, Leach and others authors have developed an encompassing framework for a political ecology/economy-based approach into science and science policy, centring on the dimensions of *direction*, *diversity* and *distribution* of science, technology and innovation (Stirling 2008; Leach et al. 2010; STEPS Centre 2010). *Direction* here refers to the technical, social and political direction of innovation, including the underlying question of benefits, stakes in particular innovations, and alternatives pathways. The choices made in science and innovation – often framed by science policy – are explained to be highly political and debatable. *Distribution* therefore relates to the share of the benefits and risks of science, technology and innovation for different social groups or causes. Bozeman et al. (2011) equally propose to investigate the distributional aspects of science-based innovations. As a means to increase social benefits of innovation, STEPS Centre researchers argue in favour of policies which foster a broad *diversity* of innovations, ranging from low to high-tech to social innovation (Stirling 2009; STEPS Centre 2010; Leach et al. 2010; 2012). From a sustainability science perspective, scholars equally call for science and science policy determined through public interests and centred on major societal and environmental challenges (WBGU 2011; Schneidewind and Augenstein 2012; Schneidewind and Singer-Brodowsky 2013a).

Given the value dimension of policies, Morlacchi and Martin point to the researcher's responsibility of analyzing policy contents to lay open the normative skew. At the same time, the authors emphasize the normative nature of the process of analysis:

> "Our task as policy scholars is not only to provide persuasive analysis that points to problems, their interpretation and possible solutions, but also to critically examine what values (and whose values) should be taken into account in doing this [...] [I]n every society at specific times certain ultimate ends (e.g. prosperity, happiness and peace) and values (e.g. freedom and democracy) result in normative rules that shape but do not determine specific actions." (Morlacchi and Martin 2009: 580)

As the empirical chapters will show, looking closely at the policies that frame science, technology and innovation means to scrutinize underlying structures and ideas, such as how decisions are made on the type and mode of science chosen for a specific purpose. Additionally, I will expose which conceptions of (sustainable) development underlie policies and what policies ultimately aim at.

## 2.3 Concepts of (sustainable) development

As I resort to (sustainable) development as a normative background of my analysis of science policy, the next sections of this chapter are dedicated to tracing different conceptualisations of both *development* as well as *sustainable development*. While today, even mainstream policy and public view development as a phenomenon encompassing social, political, economic as well as ecological aspects (Klochikhin 2012), this encompassing notion is indeed quite a recent turn: For a long time, in mainstream representations, *development* was limited to economic aspects, while *sustainability* was reduced to environmental concerns. In policy and practice the discourses of *development* and *environment* still are often dealt with by different communities in separated institutional structures (Sachs 2010a; Leach et al. 2012). Therefore, I scrutinize both terms separately. I will then expose different takes on science, technology, and innovation in the context of (sustainable) development, which will provide a backdrop for the empirical analysis of German science policy for cooperation with developing countries later.

### 2.3.1 Development

Development is a multi-faceted concept. Thomas (2000) differentiates between different denotations of the term *development*. While historical developments present one facet, another meaning denotes a vision or idea for the future, closely related to specific objectives and aspirations, which present a further meaning of the term. Last, development (cooperation) can also signify the intentional practice aimed at a specific kind of improvement. Similarly, Kothari and Minogue (2002) distinguish